NIMITZ-CLASS AIRCRAFT CARRIERS

BRAD ELWARD

ILLUSTRATED BY PAUL WRIGHT

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NEW VANGUARD • 174

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First published in Great Britain in 2010 by Osprey Publishing,
Midland House, West Way, Botley, Oxford, OX2 0PH, UK
44-02 23rd St, Suite 219, Long Island City, NY 11101, USA

E-mail: info@ospreypublishing.com

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A CIP catalogue record for this book is available from the British Library

ISBN: 978 1 84603 759 7

E-book ISBN: 978 1 84908 307 2

Page layout by Melissa Orrom Swan, Oxford
Index by Peter Finn
Typeset in Sabon and Myriad Pro
Originated by PPS Grasmere Ltd, Leeds, UK
Printed in China through Worldprint Ltd

10 11 12 13 14 10 9 8 7 6 5 4 3 2 1

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ACKNOWLEDGEMENTS

Thanks go to the US Navy; Mike Dillard, Northrop Grumman Shipbuilding Newport News; Alan J. Baribeau, CIV Naval Sea Systems Command, Public Affairs Officer; John Gourley, who provided the extensive technical information concerning the carrier electronic and radar systems; Warren Hower, researcher; Mike Maus, Deputy Force Public Affairs Officer, Commander Naval Air Force US Atlantic Fleet (COMNAVAIRLANT); LCDR Richard Burgess, US Navy (Ret.); The Tailhook Association; Ted Carlson, Fotodynamics; Jose Ramos; Fabio Pena, NavSource, www.navsource.org; and Motion Models, www.motionmodels.com (excellent professional model builders). All technical information is from open-sources.

EDITORIAL NOTE

This book uses some abbreviations of measurement with which readers might not be familiar, specifically:

ft-lb – foot-pounds
MJ – megajoules
MPa – megapascals
MW – megawatts
MWe – megawatts electrical
shp – shaft horsepower

GLOSSARY OF ABBREVIATIONS

AAG – Advanced Arresting Gear
ACDS – Advanced Combat Defense System
AIEWS – Advanced Integrated Electronic Warfare System
ARCS – Advanced Recovery Control System
AIMD – Aircraft Intermediate Maintenance Division
AAW – Anti-Air Warfare
ASuW – Anti-Surface Warfare
ACLS – Automated Carrier Landing System
BPDMS – Basic Point-Defense Missile Systems
BuAer – Navy Bureau of Aeronautics
CATCC – Carrier Air Traffic Control Center
CDC – Combat Direction Center
CEC – Cooperative Engagement Capability
CIC – Combat Information Center
CIWS – Close-In Weapon System
CVW – Carrier Air Wing
DPIA – Docketed Planned Incremental Availability
ECM – Electronic Counter Measure
EMALS – Electromagnetic Aircraft Launch System
EOB – Electronic Order of Battle
ESSM – Evolved Sea Sparrow Missile
EW – Electronic Warfare
FAS – Fueling at Sea
FDC – Flight Deck Control
FLOLS – Fresnel Lens Optical Landing System
FY – Fiscal Year
GBS – Global Broadcast System
ICCS – Integrated Catapult Control Station
IFLOLS – Improved Fresnel Lens Optical Landing System
INSURV – Independent Board of Inspections and Surveys
IPDMS – Improved Point Defense Missile System
JBD – Jet Blast Deflector
JSF – Joint Strike Fighter
LEAD – Launched Expendable Acoustic Decoy
MAD – Magnetic Anomaly Detector
MOVLAS – Manually Operated Visual Landing Aid System
MSTRAP – Multi-Sensor Torpedo Recognition and Alertment Processor
NATOPS – Naval Air Training and Operating Procedures Standardization
NGSB-NN – Northrop Grumman Shipbuilding Newport News
PIA – Planned Incremental Availability
PSA – Post Shakedown Availability
RBOC – Rapid Blooming Off-board Countermeasures
RAM – Rolling Airframe Missile
RCOH – Refueling and Complex Overhaul
SATCOM – Satellite Communications
SCB – Navy Ship Control Board
SOUTHCOM – US Southern Command
SRA – Selective Restrictive Availability
SSDS – Ship Self-Defense System
SSES – Ships Signals Exploitation Space
TACAN – TACtical Air Navigation
TARPS – Tactical Airborne Reconnaissance Pod System
TAS – Target Acquisition System
TFCC – Tactical Flag Command Center
TJS – Tactical Jamming System
USW – Undersea Warfare
VERTREP – Vertical Replenishment

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CONTENTS

INTRODUCTION 4

ORIGINS OF THE SUPERCARRIER 5

DESIGN AND DEVELOPMENT OF THE *NIMITZ* CLASS 12

- The *Nimitz* Carrier Structure
- The Flight Deck
- Aircraft Launch and Recovery Operations
- LSOs and the Lens
- The Hangar Bay
- The Island and Significant Inner Structures
- Defensive Systems
- Electronic Systems and Radars
- Integrated Air Defense
- The Carrier Air Wing (CVW)
- Propulsion and Powerplant

OPERATIONAL HISTORY 34

- The Carriers
- *Nimitz*-Class Follow-on: The USS *Gerald R. Ford* (CVN 78) Class

BIBLIOGRAPHY 47

INDEX 48

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NIMITZ CLASS AIRCRAFT CARRIERS

INTRODUCTION

US naval aviation began on November 14, 1910, when Curtiss Aircraft test pilot Eugene Ely made the first ship-launched flight in history, from the deck of the light cruiser USS *Birmingham* (CL 2), which was at anchor in Hampton Roads, Virginia. Ely followed up this achievement on January 18, 1911, when he made the first landing aboard the armored cruiser USS *Pennsylvania* (ARC 4) in San Francisco Bay. Shortly thereafter, the US Navy began funding training for the initial cadre of naval aviators.

Aircraft carriers have come a long way since the commissioning of the first US Navy carrier, the USS *Langley* (CV 1), on March 3, 1922. During the early 1920s, the Navy, impressed with the fleet's previous work with shipboard aircraft, as well as with the Royal Navy's early carrier experiments with HMS *Hermes* and *Furious*, converted the collier USS *Jupiter* (AC 3) into an experimental carrier on which to test the emerging theories of sea-based airpower. The resultant *Langley*, although too slow and small to be an

A recent image of the USS *Ronald Reagan* (CVN 76) provides a good profile of its island structure; the aft mast has been relocated to the island. (US Navy, Spike Call)

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effective carrier, nevertheless provided a means for early naval aviators to train in carrier operations.

In 1922, the Navy began exploring further developments in carrier aviation, and authorized the conversion of two battlecruisers, which became USS *Lexington* (CV 2) and USS *Saratoga* (CV 3). These two ships were the largest carriers of the time, displacing more than 36,000 tons (32,659 tonnes), and were the also fastest, capable of speeds of more than 35 knots (65km/h). They each operated more than 90 aircraft, over twice the capability of competing British and Japanese designs. The *Lexington* and *Saratoga*, together with the construction of the first planned-from-keel-up aircraft carrier, USS *Ranger* (CV 4), marked the emergence of the United States as one of the world's premier carrier powers.

From what began as a means to enhance scouting, reconnaissance, and gunnery spotting, the aircraft carrier and its embarked air wings have grown into the jewels of the US fleet, at the head of US Navy force projection and American military prestige. Today, the ten nuclear-powered carriers of the *Nimitz* class and the nuclear-powered USS *Enterprise* (CVN 65; formerly CVAN 65) form the core of US carrier power, the Carrier Strike Group (CSG). Launched in 1975, USS *Nimitz* (CVN 68) represents the first of what is undeniably the most potent and capable warship class ever built. Fully loaded, a *Nimitz*-class carrier displaces more than 97,000 tons (87,997 tonnes) and, with a flight deck greater than 4½ acres (1.8 hectares) in extent, can operate an air wing of more than 85 of the most sophisticated high-performance aircraft in the world. *Nimitz*-class carriers are the ultimate symbolic representations of American military muscle, and will remain so for the next 50 years.

What follows is an overview of the *Nimitz*-class vessels. Obvious security concerns make obtaining in-depth technical details about the carriers nearly impossible. The discussions here, therefore, focus on how the class came about, the carriers' primary electronic and defensive systems, and some of the more significant differences between the various carriers within the class. This book will also look at changes over time – most *Nimitz* carriers have been heavily modified since their initial launch, with original radars and communications antennas replaced and enhanced with more capable systems, and weapons platforms upgraded to meet new and emerging threats. Some discussion will also cover the Carrier Air Wings, which provide the offensive punch to the carrier fleet, and the next generation of carriers, the *Gerald R. Ford* class.

ORIGINS OF THE SUPERCARRIER

The vast naval campaigns of the Pacific theater of World War II were the coming of age for the aircraft carrier. Beginning with the December 1941 Japanese carrier strike on Pearl Harbor, and continuing through the final US air assaults in 1945 against Okinawa and the Japanese home islands, the offensive value of the aircraft carrier became clear, as did its supplanting of the battleship as the primary naval battle piece. By war's end, the US Navy operated more than 100 aircraft carriers, 17 of which were of the 27,100-ton (24,584-tonne) *Essex* class, the backbone of the fast carrier task forces. Although fast and capable of fielding a large air group, these carriers were already overcrowded and becoming obsolete with the advent of jet aircraft, which began entering service in the late 1940s.

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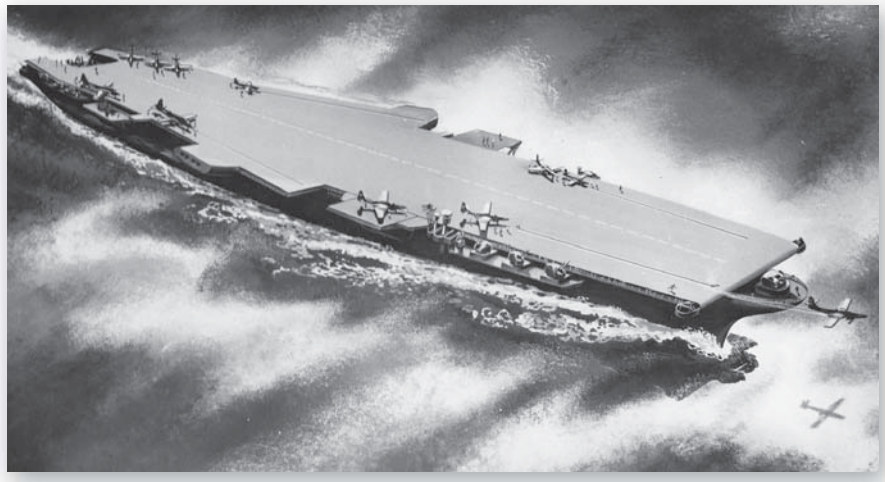

The proposed supercarrier USS *United States* (CVA 58) featured a flush deck and four steam-powered catapults, two of which were located on the edge of the flight deck. *United States* was cancelled just five days after its keel was laid down. (National Archives)

Just prior to the war, the Navy had begun design work on the larger *Midway* (CVB 41)-class carrier. Three of the new battle carriers were ordered on December 29, 1942, two days before the commissioning of the first *Essex*-class carrier, USS *Essex* (CV 9). Displacing some 45,000 tons (40,823 tonnes), the *Midway*-class carriers each operated an air group of more than 120 fighter and bomber aircraft, and incorporated many innovations derived from the lessons learned during early fighting in the war. As the war ended and defense funding dried up, the *Midway* class was limited to just three examples, *Midway*, *Franklin D. Roosevelt* (CVB 42), and *Coral Sea* (CVB 43). The two remaining *Midway* carriers, CVB 56 and 57, were canceled. *Midway*-class carriers would be the last US carriers built around the straight-deck design and the last to have prominent features of a traditional capital ship. Future carriers would be designed purely around aircraft operations.

In early 1946, work began on a new carrier design (initially termed the CVB X), one specifically able to operate the heavy jet bombers the Navy Bureau of Aeronautics (BuAer) had anticipated as entering service in the late 1940s/early 1950s. As was already apparent from the initial experimental jet fighter operations, the emergence of jet-powered aircraft presented a host of operational problems for the carriers when compared to propeller-driven aircraft. Because of their slow engine spool time, jet aircraft needed a longer take-off distance or at least assistance from catapults; likewise, the faster approach speed meant that the jets needed increased room to land and heavier arresting gear. Jet aircraft also burned large amounts of fuel, a situation that necessitated more storage on the carrier for jet fuel. The *Essex*-class carriers, as they then existed, were simply too small for such aircraft. Moreover, there was concern over the added weight of the new aircraft and the wear and tear on the wooden flight decks. The issue of jet bombers presented an even more significant problem. At the time, the Navy was pursuing several jet designs in the 100,000lb (45,454kg) range, which were too heavy for even the larger *Midway*-class carriers. It was envisioned that these bombers would carry atomic weapons, providing the Navy with a strategic asset to complement its tactical role. The initial solution to creating a carrier suited to the new demands was Navy Ship Control Board (SCB) design 6A, later named USS *United States* (CVA 58).

United States represented a monumental leap forward in capability, intended to be the first aircraft carrier specifically designed to operate jet aircraft. With

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an overall length of 1,090ft (332m) and a molded beam of 130ft (40m), it would displace more than 65,000 tons (58,967 tonnes), making it easily the largest warship of its time. It was to feature four catapults – two on the bow and one on each side of the flight deck – capable of launching the new heavy jet bombers. The carrier was of a flush-deck design with four aircraft elevators, in an effort to provide as much operational space for air operations as possible. The total air wing was planned at 12–18 heavy bombers, each with a planned 2,000-mile (3,218km) range, and 54 jet fighters. Reflecting its immense size and capabilities, the Navy termed the *United States* a "supercarrier."

USS *United States* (CVA 58)	
Displacement	65,000-ton (58,967-tonne) class; 83,350 tons (75,614 tonnes), fully loaded
Length	1,090ft (330m) overall; 980ft (300m) waterline
Beam	130ft (40m)
Flight deck	1,088ft (332m) by 190ft (58m)
Propulsion	8 x 1,200psi (8.3MPa) Foster-Wheeler boilers; 4 x Westinghouse geared steam turbines; 4 x 20ft 6in (6.2m) propellers; power output of 280,000shp (209 MW); top speed of 33 knots (61km/h)
Armament	8 x 5in/54-caliber guns in single mounts; 16 x 76mm/70-caliber guns in eight twin mounts; 20 x Oerlikon 20mm cannons
Crew	3,019 officers and crew; 2,480 air wing officers and crew

As the Navy moved forward with its design, a rivalry that already existed between the Navy and the US Air Force (USAF), concerning the proper mission and organizational structure of the various services, escalated even further. The Air Force, which at the time placed all of its faith in strategic bombing, had proposed a large fleet of heavy bombers (70 air groups) based on the Convair B-36 Peacemaker, which had entered service in August 1946. Fearful that the Navy's supercarriers and carrier-based bombers would encroach on its strategic bombing mission, the Air Force bitterly fought the construction of *United States* and its jet bombers. The Navy, while desiring an organic atomic capability, nevertheless saw the nuclear mission as a supplement to rather than a replacement for the Air Force's strategic bombing role. Clearly the Navy sought a platform that could continue to enhance the tactical strike capabilities developed during World War II, as well as one for sea control and support of amphibious operations.

With the limited funding available after the war and a massive demobilization underway, the US military could not afford to pursue a fleet based around the $189 million supercarriers, and at the same time purchase the proposed 100 B-36 strategic bombers sought by the Air Force. Based on its experiences in the Pacific theater during World War II, the Navy argued that the bombers would be of limited value against Soviet air defenses and that the flexible supercarrier battlegroups offered the most cost-efficient means of striking Soviet targets.

The Navy obtained approval for its new supercarrier, the first of five planned, on July 29, 1948, when President Truman signed the Naval

The keel of USS United States was begun on April 18, 1949, and cancelled five days later. The shape of the keel, seen here in dry dock, shows the immense size of the carrier. (National Archives)

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Appropriations Act of 1949. Construction of the keel began on April 18, 1949, at Newport News Shipyard in Virginia. Yet President Truman's Secretary of Defense, Louis Johnson, who sided with the Air Force's strategic viewpoints, abruptly cancelled *United States* just five days later, on April 23, without consulting the Secretary of the Navy or the Chief of Naval Operations. The carrier fleet was likewise reduced from eight to four *Essex*-class carriers, three *Midway*-class carriers, and the number of air groups from 14 to six. As a consolation, the Navy was authorized to pursue improvements to the *Midway* class, modernize the wartime *Essex* carriers, deploy the AJ-1 Savage, and develop the 70,000lb (31,818kg) jet-powered heavy bomber that became the A-3 Skywarrior.

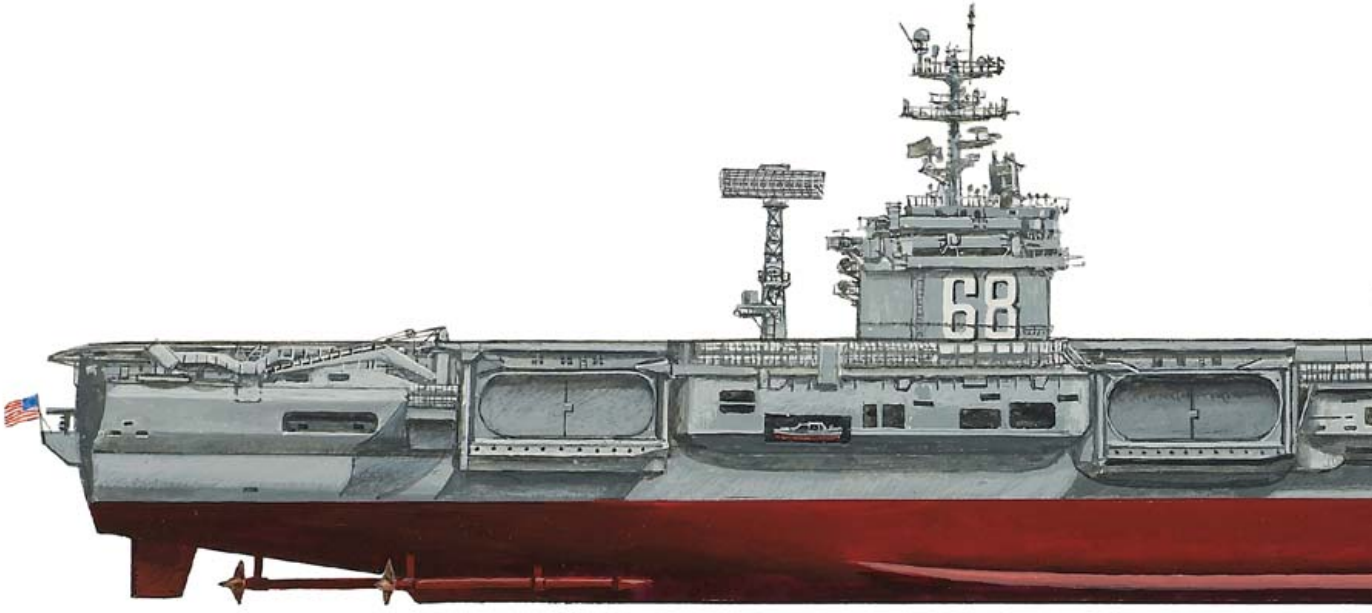
Although *United States* was never built, it nevertheless served as the starting point for construction of what would become one of the most

A

THE ORIGINAL USS *NIMITZ* (CVN 68) CONFIGURATION

When launched in 1975, the USS *Nimitz* had a different appearance compared with the vessel today. The two most notable modern differences are the absence of the bridle catchers, located off the bow, and the modifications to the carrier's island structure and antennas. The bridle catchers were part of the bridle arrester system used with older aircraft, such as the A-5 Vigilante, which still operated from the *Nimitz* during the 1970s. USS *Dwight D. Eisenhower* (CVN 69) and USS *Carl Vinson* (CVN 70) were built with a single bridle catcher on Catapult No. 1. These have all since been removed.

When commissioned, the ship had a basic radar suite, consisting of the SPS-10 surface radar, the standard such radar of the day, and the SPS-43 2-D air search and SPS-48A 3-D air search radars. Today the *Nimitz*'s island has been reconstructed out of composites and features the SPS-48E 3-D air search and SPS-49A 2-D air search radars, as well as the SPS-65 surface search radar. The island also bristles with many smaller navigation radars and Satellite Communications (SATCOM) radomes, some mounted to the forward island just below the Flag Bridge.



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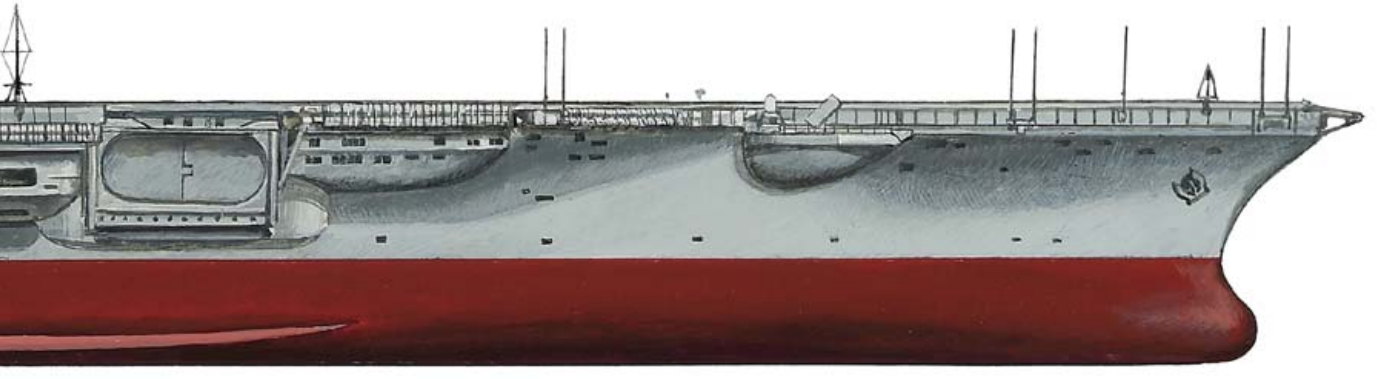
significant postwar aircraft carrier designs, the *Forrestal* class. Even after the cancellation of *United States*, Navy planners continued working on the design and explored potential improvements, including those of the steam-powered catapult and angled flight deck, as were being studied by the Royal Navy. Despite the obvious deficiencies in the *Essex*- and *Midway*-class carriers, interest in expanding the carrier force did not surface until the outbreak of the Korean War in June 1950. At the time, American, British, and Australian carriers were the only air forces capable of providing tactical resistance to the North Korean onslaught.

Given the lessons of the Korean War, and the shortfalls of the current carrier fleet composition, the Navy once again pushed for development of a new carrier, essentially a scaled-down version of the canceled *United States*. This time the Navy was successful. Named in honor of the first US Secretary of Defense and World War I naval aviator, James Vincent Forrestal, the USS *Forrestal* (CV 59) displaced 59,000 tons (53,523 tonnes) and measured 1,039ft 9in (316.9m) in length and 129ft 6in (39.5m) in beam. The flight deck incorporated several British innovations, including the armored, angled flight deck and steam catapults, and also introduced the Fresnel Lens landing system. *Forrestal* represented a multi-generational leap forward in carrier design. Indeed, as carrier historian Norman Friedman stated in his work, *US Aircraft Carriers: An Illustrated Design History*, the *Forrestal* was so successful that it formed the basis for all subsequent US Navy carrier designs.

Ultimately, four *Forrestal*-class carriers were built between 1954 and 1959: *Forrestal*, *Saratoga* (CVA 60), *Ranger* (CVA 61), and *Independence* (CVA 62). Two improved *Forrestal*-class vessels, designated the *Kitty Hawk* class, were also built (*Kitty Hawk*, CVA 63 and *Constellation*, CVA 64). USS *America* (CVA 66) and USS *John F. Kennedy* (CVA 67), commissioned in 1965 and 1968 respectively, were considered "improved" *Kitty Hawk*s, though many considered *John F. Kennedy* its own class. *Kitty Hawk*-class carriers featured



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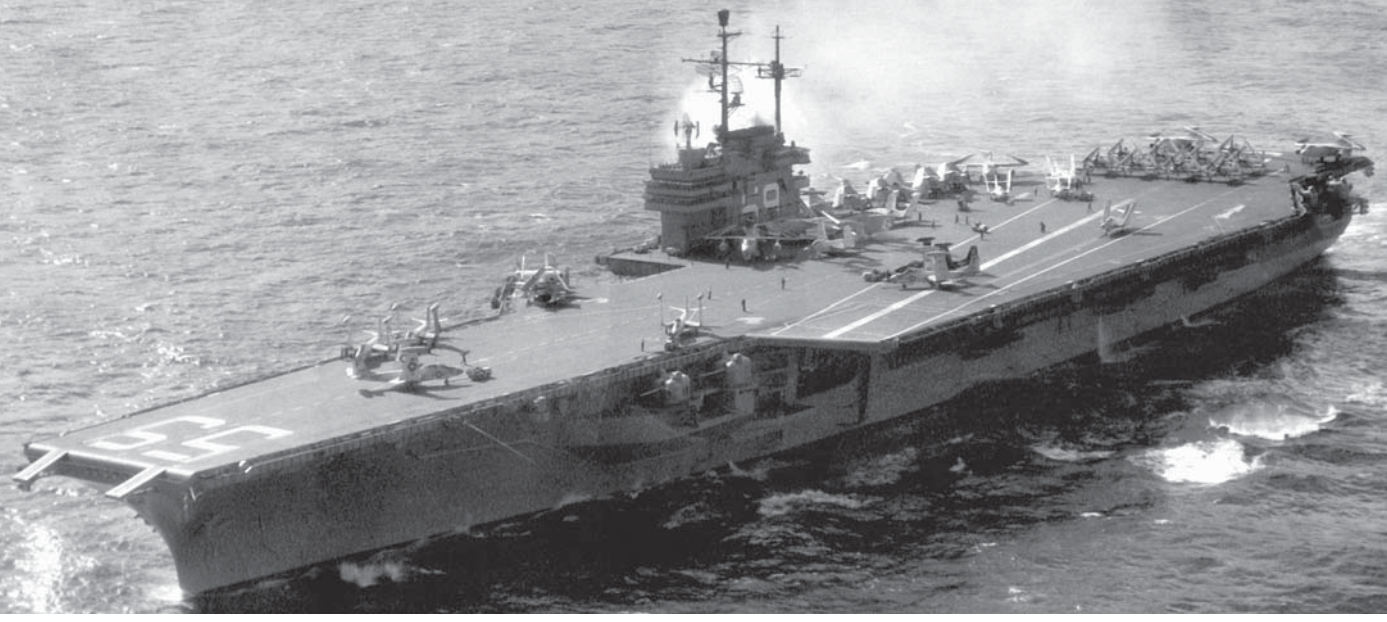

No carrier influenced the design of the *Nimitz*-class carriers more than USS *Forrestal* (CV 59). Shown here in 1956, *Forrestal* was named after the first Secretary of Defense, James Forrestal. (US Navy)

a modified flight deck that moved one of the two aft starboard elevators forward of the island and also positioned the No. 4 elevator, which was previously located at the forward end of the port-side angled deck, to the aft deck.

The USS *Nimitz* design owes its origins not only to the design of the USS *Forrestal*, but also to the many failed efforts at making a more affordable version of the nuclear-powered USS *Enterprise*. Although talk of nuclear-powered aircraft carriers dates back to the early days of designing the *United States* (alternative designs called for introducing nuclear propulsion later in the class construction), the Navy did not seriously undertake studies into nuclear powerplants until the early 1950s, and then only in land-based prototypes. In November 1951, the Joint Chiefs of Staff established a formal requirement for a carrier reactor. At that time, the only studies underway focused on nuclear powerplants for submarines, which were very different from the units needed for large surface vessels. Thus, the idea of simply up-scaling the submarine design was not feasible. In 1954, a research and development program began with the goal of developing five reactor prototypes: submarine, frigate, destroyer, cruiser, and carrier.

By the mid-1950s, reactor technology had advanced sufficiently for the construction of a nuclear-powered carrier. Thus, in Fiscal Year (FY) 58, funds were allocated for construction of the first nuclear-powered carrier, USS *Enterprise* (design SCB 160). *Enterprise* was a huge ship, measuring 1,123ft (342.3m) in length and displacing some 68,000 tons (61,689 tonnes). Powered by eight Westinghouse A2W reactors, each providing 35,000shp (26 MW), the hull had to be enlarged to accommodate the size of the reactors, which meant a much larger flight deck (1,079ft/328.8m by 235ft 3in/71.7m, and 720ft/219.4m for the angled deck). *Enterprise* also featured a *Kitty Hawk*-class flight deck configuration. One additional feature that identified *Enterprise* as unique among carriers was its rather unusual square island. Because the carrier was nuclear-powered, there was no need for exhaust funnels to vent off internal gases. Even more so, what made the *Enterprise*'s superstructure unique was the then-revolutionary twin-element phased planar array radar system (the vertical and horizontal so-called "billboard" radar antennas on the island's upper surfaces). The phased-array radars, the horizontal SPS-32 air surveillance and the vertical, target-tracking SPS-33, together formed the SCANFAR system, itself a modified version

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Shown here underway in the Atlantic in 2004, USS *Enterprise* (CVN 65) was the world's first nuclear-powered aircraft carrier. (US Navy, Rob Gaston)

of the SPG-59 "track-while-scan" phased array (a precursor to the SPY-1 Aegis system).

The new carrier was exceedingly expensive, however, costing nearly $500 million by 1961. Moreover, construction of *Enterprise* took longer than conventional carriers, which conflicted with the Navy's one-carrier-per-year plan towards a goal of 13 carriers. As a result, the consideration shifted to whether it was feasible to construct a scaled-down version of *Enterprise*, utilizing a large flight deck while retaining the benefits of nuclear propulsion. Early efforts proved unsuccessful, with designs either too small to operate an effective air wing or speeds too slow for conducting fleet action. As earlier studies had shown, the chief problem was the size of the reactors. They were simply insufficiently powerful to allow a reduction from the eight used by *Enterprise* to four.

Finally, by 1964, the Board proposed SCB 250 (later redesignated SCB 102), which represented a flight deck 10ft (3.2m) shorter than that of *Enterprise* and utilized four of the long C-13 Mod 1 catapults. The original cost estimate was $430.4 million. Beam was set at 134ft (40.8m), reflecting the limitations of the building docks, and overall length was to be 1,040ft (317m), with a total flight deck length of 1,100ft (335.3m). The flight deck layout was based on that of *John F. Kennedy*, with minor changes to the degree of the angled deck, as were the electronics, the Navy having rejected the idea of using the phased-array system, which was designed into *Enterprise*.

During the mid-1960s, the procurement of aircraft carriers took a hiatus from the heavy acquisition schedule of the late 1950s. Despite efforts to produce a nuclear-powered design, the last conventional carrier, USS *John F. Kennedy*, had been ordered as late as FY 63. In February 1966, however, Defense Secretary Robert S. McNamara, impressed with the *Forrestal* and *Kitty Hawk*-class carriers' performance off the coast of North Vietnam, announced that defense maritime policy now required a force of 15, rather than 13, carriers, and that to reach that goal the Navy would procure three new nuclear carriers. This new carrier would be derived from the SCB 250 design, featuring two more powerful A4W reactors. In 1967, the first of this new class of nuclear carriers, USS *Nimitz* (CVAN 68), was ordered.

The improved *Forrestal*-class USS *Kitty Hawk* (CV 63) was the Navy's last conventional aircraft carrier. Commissioned in 1961, *Kitty Hawk* featured a modified flight deck – its No. 4 elevator and island were moved aft, allowing elevators Nos. 1 and 2 to be positioned more forward. This configuration was adopted on all subsequent carriers. On June 30, 1975, the carrier's classification was redesignated from CVA (attack carrier) to CV (multipurpose aircraft carrier). (US Navy via NavSource)

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DESIGN AND DEVELOPMENT OF THE *NIMITZ* CLASS

The *Nimitz* Carrier Structure

The following section is meant to give the reader an idea of the essential and significant systems of *Nimitz*-class carriers. These descriptions, except where noted, apply to all *Nimitz*-class vessels. Generally speaking, the carrier's hull is constructed of extremely strong high-tensile steel plates, several inches thick, which protect against fire and battle damage. The carrier's internal support largely comes from three horizontal structures – the double-bottomed keel, the flight deck, and the hangar deck – extending across the entire hull and forming a rectangle. The portions of the hull below the waterline are rounded and relatively narrow as compared to the section above water, which flares out to accommodate the wide flight deck space. Despite this shape, and in part due to elaborate stabilizers, the carrier is exceedingly stable. The lower section of the carrier features a double bottom consisting of two layers of heavy steel plating separated by a small gap. This design provides extra protection against damage from torpedoes or collisions.

Inside the ship there are 23 watertight transverse bulkheads, with more than 2,000 compartments, as well as ten firewall bulkheads. According to open-access publications, *Nimitz*-class carriers can withstand more than three times the damage that could be endured by *Essex*-class carriers of World War II, and can absorb impact and shock waves in at least the same proportions for its size. The remarkable size of the *Nimitz* carriers allows them to carry 90 percent more aviation fuel than *Forrestal*-class carriers and 50 percent more ammunition (nearly 3,000 tons/2,722 tonnes).

A photo of USS *Nimitz* (CVN 68) taken during the 1990s shows the bridle catcher attached to Catapult No. 1. Also visible are many of the carrier's air wing aircraft, most notably F/A-18C Hornets and F-14 Tomcats. (US Navy)

The Flight Deck

The flight deck is the most logical place to start any detailed discussion of the *Nimitz* carriers, for here is the essence of the carrier's offensive capability. The *Nimitz* flight deck is immense, measuring 1,092ft (332.8m) by 250ft 8in (76.4 m) and totaling more than 4½ acres (1.8 hectares). Indeed, so large is the flight deck that three separate National Football League games could be played simultaneously on its surface. The flight deck features an angled deck, set at 14 degrees off-center, which serves as the landing area for recovering aircraft and also allows aircraft to be launched simultaneously from the bow catapults.

As the diagram opposite shows, the flight deck has four catapults, two located on the bow and two located on the port side, referred to as the "waist catapults." Located just behind each catapult is a Jet Blast Deflector (JBD), which lies flush with

B

AERIAL VIEW OF A *NIMITZ*-CLASS CARRIER

The flight deck of a *Nimitz*-class carrier covers over 4½ acres (1.8 hectares), and during flight operations is regarded as one of the most dangerous places on Earth to work. This view highlights the location of the four steam-powered catapults and the four elevators, as well as the JBDs. The catapults are Type C Mk 13 Mod 1 (Mod 2 in *Theodore Roosevelt* and beyond) and measure 310ft (94.48m) long. Catapult No. 4, which is located on the port side nearest the flight deck edge, is not capable of launching aircraft at full weight due to wing clearance problems. This deficiency was corrected in the USS *Ronald Reagan* (CVN 76) and *George H.W. Bush* (CVN 77) designs. The *Nimitz* flight deck measures 1,092ft (332.8m) long and the angled deck portion, where aircraft are recovered, is offset at 14 degrees. All *Nimitz*-class carriers feature four arresting wires for recovering aircraft, except *Ronald Reagan* and *George H.W. Bush*, which have three.

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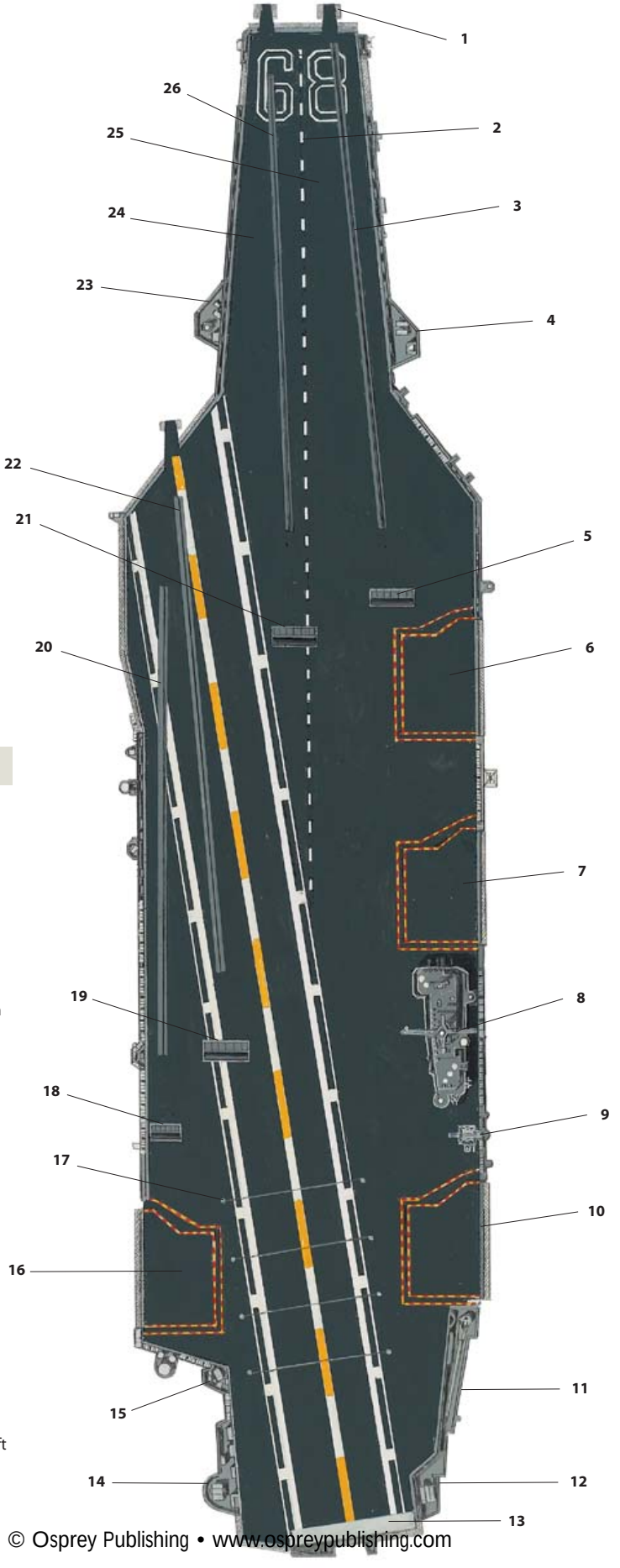

Key

1. Bridle Catcher (3)
2. Center Line
3. Catapult No. 1
4. BPDMS Sea Sparrow
5. Jet Blast Deflector (JBD) No. 1
6. Elevator No. 1
7. Elevator No. 2
8. Island
9. Aft mast with SPS-43 air search radar
10. Elevator No. 3
11. Crane
12. BPDMS Sea Sparrow
13. Ramp above fantail
14. BPDMS Sea Sparrow
15. Landing Signal Officer (LSO) Platform
16. Elevator No. 4
17. Arresting gear (4 wires)
18. Jet Blast Deflector No. 4
19. Jet Blast Deflector No. 3
20. Catapult No. 4
21. Jet Blast Deflector No. 2
22. Catapult No. 3
23. BPDMS Sea Sparrow
24. "Row" area for parking aircraft
25. "Street" area for parking aircraft
26. Catapult No. 2

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the carrier deck and is elevated to a 45-degree angle during launch, to deflect jet exhaust away from the deck. Four elevators, three on the starboard side (two forward and one aft of the island superstructure) and one on the port side, provide a means of transporting aircraft from the hangar bar to the flight deck. The flight deck is bordered by steel netting, serving as a safety net for deck personnel. The deck itself is made of high-strength steel, the exact thickness of which is classified, and is coated with a thin layer of Kevlar ablative (MS-375G), which serves as a non-slip coating as well as protection for the deck.

To aid communications, each area of the deck has been assigned a specific name, which is used by the flight deck and air traffic control personnel. For example, the "Strut," and the area outside Catapult Nos. 1 and 2 are the "Row."

The island on *Nimitz*-class carriers differs from that on the *Forrestal* class in many ways. Most notable, perhaps, is the movement of Primary Flight Control (Pri-Fly) from aft to the forward section of the island and the movement of the island itself aft to accommodate repositioning of the two forward elevators (incorporated in the *Kitty Hawk* class).

Deck personnel

Deck activity is oriented around two events – the launch and recovery of aircraft. To accomplish these tasks, the carrier has teams of personnel with highly specialized duties, who tend to the aircraft, carry out refueling, maneuver the aircraft over the deck, handle armaments, and oversee launch and recovery. Each task requires a high level of training. Flight deck personnel wear a standardized uniform consisting of steel-toed boots, rugged pants, gloves, and ear and eye protection, but also wear a special life jacket called a "float coat" and a cranial. The float coat and cranial are color-coded to identify each person's task on the deck.

Flight operations are controlled by five individuals: the Air Boss, Mini Boss, the Handler, Air Bos'n, and the Landing Signal Officer (LSO). The Air Boss, officially the Air Officer, is a post-squadron command aviator and is located in the Pri-Fly on the 010 level (the very top) of the carrier island. Sitting six stories above the flight deck, Pri-Fly has a full view, aft and forward, of flight activities, and controls all aircraft on the deck and those in flight within a 5-mile (8km) radius. The Mini Boss, officially called the Air Officer Assistant, helps the Air Boss. The Handler, from his or her position in Flight Deck Control (FDC), controls the movement of all aircraft on the flight deck and in the hangar, and uses what is described as the "Ouija Board" to monitor the aircraft – this is a large-scale diagram of the carrier deck, with small cutouts of each aircraft. The cutouts are marked with aircraft numbers, such as "101," and are marked with objects to reflect the flight event, any problems, and fuel status.

A catapult crew member directs an F-14B Tomcat of VF-11 onto one of the four steam-powered catapults aboard *George Washington* (CVN 73). (US Navy, Michael D. Blackwell II)

The Air Bos'n is responsible for all aircraft emergencies during flight and General Quarters and is supported by a staff of officers, taken from each airborne squadron, standing by with aircraft-

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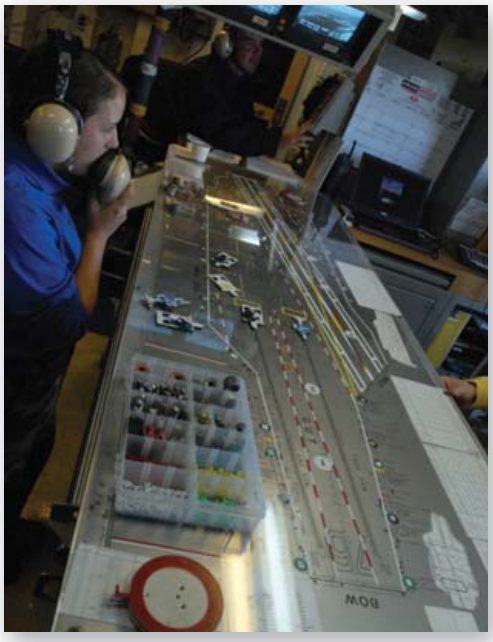

specific Naval Air Training and Operating Procedures Standardization (NATOPS) flight manuals. Located just off the flight deck, meanwhile, the LSO controls the aircraft from three-quarters of a mile out while on their final approaches. The LSO's exact job duties are described in more detail on page 18.

The carrier flight deck is often called the most dangerous place on Earth, and rightly so. With dozens of aircraft moving about, launching and landing, dangers loom at every turn. Of the perils faced by flight deck personnel, the most serious are ingestion into a jet intake, being blown overboard, burnt by a powerful jet engine exhaust, and being struck by a jet. The flight deck crews are also exposed to the elements, which means many unbearably hot days operating in the Persian Gulf and Indian Ocean, as well as frigid days in the North Sea. Recent operations in support of Operation *Iraqi Freedom* have seen flight deck temperatures ranging upwards of 140°F (60°C).

ABOVE LEFT
All carrier aircraft are tracked using this scale flight deck model called the "Ouija Board." The small objects in the plastic box are used to denote various aircraft conditions, such as fuel state or deficiencies. (US Navy, Jennifer S. Kimball)

ABOVE RIGHT
Landing Signal Officers (LSOs) are responsible for bringing the aircraft aboard the carrier during final approach. Here, an LSO and his backup communicate to the approaching aircraft using the phone, and control the Fresnel Lens lights with the device in their right hand, called the "pickle." Another LSO records the comments and observations about the landing, which are later shared with the pilot down in the squadron ready rooms. (US Navy)

Aircraft Launch and Recovery Operations

Launching aircraft requires the assistance of steam-powered catapults. Each *Nimitz*-class carrier has four catapults, two located on the bow, designated Catapult Nos. 1 and 2 from starboard to port, and two located on the port side, known as Catapult Nos. 3 and 4, again from starboard to port. The latter two are also referred to as the waist catapults. Together, the four catapults can launch one aircraft every 20 seconds. *Nimitz* through USS *Theodore Roosevelt* (CVN 71) feature four C-13 Mod 1 catapults, which are considered heavy-duty catapults. The C-13 replaced the C-7 used by the *Forrestal* class, and operates at 1,000psi (6.9 MPa). It measures 310ft (94.4m) and can launch one aircraft per minute. The Mod 1 catapults are extremely powerful, capable of accelerating an aircraft from 0 to 160 knots (296km/h) in less than three seconds. Beginning with *Abraham Lincoln* (CVN 72), the catapults were modified to the C-13 Mod 2 standard, which is a low-pressure catapult. The Mod 2 reduces the steam demands on the reactor, which in turn increases the reactor's core life. Both the Mod 1 and Mod 2 are capable of launching aircraft without a headwind. The next-generation *Gerald R. Ford* (CVN 78; estimated for completion in 2015) will be fitted with the new Electromagnetic Aircraft Launch System (EMALS); this system likely will not

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TOP
An F/A-18F Super Hornet from VFA-102 "Diamondbacks" launches from USS *George Washington* (CVN 73) during combat operations efficiency evaluations in the western Pacific Ocean in early 2009. Two Jet Blast Deflectors (JBDs) are located aft of the bow catapults. (US Navy, Rachel N. Clayton)

BELOW
Steam can be seen along the catapult run on the bow of USS *Theodore Roosevelt* (CVN 71) as two VFA-15 "Valions" F/A-18Cs prepare for launch. (US Navy, Javier Capella)

be retrofitted into the *Nimitz*-class carriers because of the increased electrical demands.

When commissioned in 1975, USS *Nimitz* featured two Van Velm bridle arresters, or bridle retrieval horns, on the bow catapults, which appear as small extensions. The bridle was used to launch older aircraft, such as the RA-5C Vigilante and certain versions of the F-4 Phantom II, which continued in service until the early 1980s. USS *Dwight D. Eisenhower* (CVN 69) and USS *Carl Vinson* (CVN 70) each had a single bridle arrester on Catapult No. 1. These were subsequently removed during various maintenance periods, although *Nimitz* retained its bridle arrester on Catapult No. 1 until it entered its Refueling and Complex Overhaul (RCOH) in 1997.

The power of catapults is combined with jet-engine thrust, as well as old-fashioned wind-over-deck. As in the early days of carrier aviation, *Nimitz* carriers are "turned into the wind" to take advantage of the windspeed over deck, which creates additional lift. This factor, combined with the carrier's own speed, can produce as much as 50 knots (93km/h) of windspeed – a carrier steaming ahead at 30 knots (56km/h) into a 20-knot (37km/h) wind – thereby reducing the power needed to launch an aircraft by 50 knots, or assisting launch when the aircraft is near full weight.

Located a few yards behind each catapult is the large, rectangular, hydraulically controlled JBD. The JBDs remain flush with the carrier deck until immediately before launch, when they are elevated to a 45-degree angle and locked into place. The JBDs are made of concrete and contain an embedded cooling system (using seawater) that prevents damage from the hot engine exhaust. Each JBD consists of six sections that can be independently moved. The structures deflect the engine exhaust during launch and protect both aircraft and flight deck crews.

Aircraft aboard *Nimitz*-class carriers are launched by officers situated in the Integrated Catapult Control Station (ICCS), also called the "bubble." The bubble is just as it sounds: a small glazed dome located between Catapult Nos. 1 and 2 and, on the port side of the carrier flight deck, left of Catapult No. 4. The bubble offers protection for the "shooter" who launches the aircraft, and it is retracted into the flight deck when not in use. The bubble was introduced in 1975, but was not built into early *Nimitz*-class carriers; it was later retrofitted during yard periods. Prior to incorporation of the bubble, the catapult officers were regularly seen sitting in small open-hatched

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areas holding a catapult control board on their laps, receiving final instructions from the shooter standing on the flight deck.

Aircraft are recovered using the Mk 7 Mod 3 arresting gear system consisting of four arresting cables and an emergency crash barrier located at the rear of the carrier's angled flight deck. The arresting cables, called cross-deck pendants or "wires" by those aboard the carrier, are made of 1 7/16th-inch (36mm) thick braided polyester-core flattened-strand steel, and are numbered one through four, from back to front. Each cable is spaced approximately 50ft (15m) apart and stretches across the entire angled flight deck. For *Nimitz* through *Harry S. Truman* (CVN 75), the above-deck span is 120ft (36.5m); USS *Ronald Reagan* (CVN 76) and USS *George H.W. Bush* (CVN 77), which each have only three wires, have a 110ft (33.5m) span. The cables weigh approximately 3.5lb (1.58kg) per foot.

Landing aboard an aircraft carrier requires pilots to "catch" an arresting cable stretched across the carrier's aft deck. Officially called a "cross deck pendant," the so-called "wire" enters the deck through a retractable sheave. Here, an F/A-18C Hornet from VFA-94 "Mighty Shrikes" marks the first aircraft to land aboard *Carl Vinson*'s flight deck following completion of the vessel's scheduled maintenance period in late 2002. (US Navy, Inez Lawson via NavSource)

Ronald Reagan incorporates a new arresting gear system known as the Advanced Recovery Control System (ARC), which replaces the older mechanical systems with state-of-the-art digital control technology. While *Ronald Reagan* was not built with the system, it was added during the carrier's 2007 scheduled maintenance period. The ARC will be retrofitted into earlier *Nimitz*-class carriers and will be installed on the *Gerald R. Ford* class. A further system is currently being researched, called the Advanced Arresting Gear (AAG) program, and will eventually replace the entire Mk 7 hydraulic system of both *Nimitz*- and *Gerald R. Ford*-class carriers.

The cross-deck pendants enter the flight deck through a retractable sheave on each side and run below the deck into the arresting control room, where they are attached by a purchase cable to the hydraulic cylinders of the arresting engine. The pendants are tension-adjusted for each aircraft type, taking into account the aircraft's weight, fuel state, and weapons load, and are elevated slightly (2–5½in/50–140mm) above the flight deck by a series of flat leaf springs (called "fiddle bridges," as they resemble a violin bridge and strings). When an aircraft catches a wire or pendant, the purchase cable extracts from the

A barricade can be erected to "catch" incoming aircraft in emergencies. Located aft of the fourth wire, it is stored under deck and can be raised in less than two minutes. The webbing has an upper and lower horizontal strap and five vertical engaging straps, spaced 20ft (6.09m) apart, and is stretched across the flight deck between two stanchions. The barricade stands 20ft (6.09m) tall and engages the aircraft's wings. (US Navy)

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A catapult shooter located in the shooter's bubble aboard *Theodore Roosevelt* (CVN 71) prepares to launch a VFA-102 F-14 Tomcat. The "Diamondbacks" are part of Carrier Air Wing One (CVW 1) and were deployed in support of Operation *Enduring Freedom*. (US Navy, Angela Virnig)

arresting housing and absorbs the shock of the landing. With an energy-absorbing capacity of some 47,500ft-lb (64.4 MJ), the arresting system can bring a 50,000lb (22,727kg) jet traveling at a speed of 130 knots (241km/h) to a complete stop in less than 340ft (104m). Each cable, however, must be replaced after 125 "traps".

Successfully catching an arresting cable is called a "trap." Although there are four wires, pilots strive for the third wire, which is considered an "OK", or safe, landing. Catching the one-wire means landing too close to the fantail; this is dangerous and can lead to a ramp strike if the pilot miscalculates. The four-wire can be equally problematic; missing it can often leave too little time for the aircraft to recover the airspeed needed to take to the sky for a second attempt.

LSOs and the Lens

As mentioned earlier, the Air Boss maintains control over all aircraft within 5 miles (8km) of the carrier. However, control is passed to another officer as the aircraft makes its final approach behind the ship. At approximately ¾ mile (1.2km), control is passed to the LSO, who communicates with the pilot and assists in bringing the aircraft aboard. The LSO is actually part of a team of LSOs located on a small sponson called the LSO Platform just off the port side of the angled deck. The LSO team consists of one LSO from each of the squadrons flying, as well as an air wing LSO. Squadron LSOs are typically lieutenants and can land only the aircraft in their squadron or of similar type. Wing LSOs are in many cases lieutenant commanders and are qualified to land all of the aircraft in the wing. The LSO in charge of the incoming aircraft communicates directly with that aircraft using voice communications and also uses a small hand switch known as the "pickle," which controls the Fresnel Lens unit. The LSO can trigger the pickle and immediately send the Fresnel Lens into a "wave-off" mode, telling the pilot to power up and make a second pass.

The Mk 6 Mod 3 Fresnel Lens Optical Landing System (FLOLS) was a visual reference system for landing aboard the carrier. It was based on the old mirror landing aid developed by the British after World War II. The FLOLS consisted of a series of datum lights and a "ball" (called the "meatball" in Navy parlance). Pilots determined their relation to the desired glide path by the position of the ball in reference to the datum lights. If the ball was above the datum lights, the plane was too high; if below the datum lights, the plane was too low. A pilot used the FLOLS together with minor corrections from the LSO to make his or her landing.

The Improved Fresnel Lens Optical Landing System (IFLOLS), which offered improved stabilization and a sharper, crisper light, was first tested on USS *George Washington* (CVN 73) in 1997 and is now used on all *Nimitz*-class carriers. Each carrier also has a portable lens system for use as

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backup if the primary system malfunctions or is destroyed. Called the Manually Operated Visual Landing Aid System (MOVLAS), the system presents the same visual information to pilots as the IFLOLS. It can be installed in three modes: Station 1 is just in front of the IFLOLS and uses the IFLOLS wave-off, datum, and cut lights; Station 2 and 3 are located on the flight deck port and starboard and do not interface with the IFLOLS.

The vastness of the hangar bay is illustrated here. The bay measures 684ft (208.5m) long and 108ft (33m) wide, and stands 25ft (7.6m) high. (US Navy, Joseph Pol Sebastian Gocong)

The Hangar Bay

The hangar bay is located just below the flight deck and runs approximately two-thirds of the length of the carrier. Overall, the hangar measures 684ft (208.5m) long and 108ft (33m) wide, and stands 25ft (7.6m) high – almost three stories. The bay is divided into three equal-sized areas and separated by a series of massive, armored, power-sliding doors that, together with an elaborate fire-suppression system, serve to limit damage caused by fire or explosions. The hangar bay, while huge, can only store about 50 of the air wing's aircraft; thus, some aircraft are always parked on the flight deck. The hangars are used for maintenance and repair work and for storage of parts, spare engines, and aerial drop tanks (kept in overhead storage racks). The Aircraft Intermediate Maintenance Division (AIMD) is located just aft of the hangar bay.

To transfer aircraft between the hangar and flight deck, the carrier relies on four large elevators positioned around the perimeter of the flight deck and hangar bay. The starboard elevators are designated one through three, running from bow to stern, and No. 4 elevator is located on the aft end of the port flight deck. Each elevator, which is made of aluminum, measures 52ft (15.2m) wide, and they are 70ft (21.3 m) long inboard and 85ft (25.9m) long outboard, the difference being the small triangular area specifically designed to accommodate the A-3 Skywarrior, to date the largest aircraft deployed aboard any carrier. The total area of each elevator measures 3,880ft^2 (360m^2). Each is capable of supporting 47 tons (42.6 tonnes) – the equivalent of two fully loaded F-14 Tomcats). The elevators are segregated from the hangar bay by heavy steel doors, which seal the large oval openings.

One of *Harry S. Truman's* 47-ton (43-tonne) aluminum elevators lowers an F/A-18C Hornet from VFA-37 and an EA-6B Prowler from VAQ-130 to the hangar bay. (US Navy, Kristopher Wilson)

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A VFA-41 "Black Aces" F/A-18F Super Hornet is moved onto an elevator to transfer the aircraft to the *Nimitz* flight deck. (US Navy, Mass Communication Specialist 1st Class David Mercil)

The Island and Significant Inner Structures

The carrier's island structure is the central command-and-control facility for the carrier and for air operations. While various combat facilities are located below deck, and are discussed in other sections of this book, the island contains the Bridge, Flag Bridge, and Pri-Fly center. Pri-Fly is located on the top or 010 level of the island; just aft is the open-area called "Vulture's Row," where crew can observe air operations without the hazards inherent on the flight deck. Just below Pri-Fly is the Bridge, where the carrier itself is controlled. From here, the carrier's commanding and executive officer control and navigate the carrier. Beginning with USS *Harry S. Truman*, many of the controls and displays are now digital (as per the Sperry Integrated Bridge System). Flag Plot is located below the Bridge on the 08 level and is where the commanding admiral or CSG commander can observe operations. Flag Plot used to be where admirals conducted battlegroup operations; that position has subsequently been relocated to the Tactical Flag Command Center (TFCC) below the flight deck.

Both *Ronald Reagan* and *George H.W. Bush* feature a redesigned island structure and a composite mast. Pri-Fly was enlarged, with more square-footage as well as larger windows, and the aft mast was relocated from the flight deck to the island to put it in closer proximity to other radar systems. *Nimitz* and *Dwight D. Eisenhower* both had the top two levels of their islands altered (one level was removed entirely) and a new integrated mast/antenna shelter installed during their respective RCOH periods.

The inner carrier is itself divided into various levels, all referenced from the hangar deck. Levels above the hangar are numbered, such as 01 Deck, 02 Deck, etc, while levels below are spelled out, such as Second Deck, Third Deck, etc. Whether one travels above or below the hangar deck, the level increases. The bulk of the air wing and aviation-related command facilities are on 03 Deck (or Gallery) located immediately below the flight deck. Here we find the squadron

C

F-14D LANDS ABOARD USS *ABRAHAM LINCOLN* (CVN 72), 2008

Bringing an aircraft aboard a moving aircraft carrier is one of the most difficult and demanding tasks faced by naval aviators. Here, an F-14D Tomcat from VF-31, the "Tomcatters," is just seconds away from landing aboard USS *Abraham Lincoln* (CVN 72). VF-31 was then part of Carrier Air Wing Eight (CVW 8) and deployed with sister squadron VF-213. Both squadrons have now transitioned to the F/A-18 Super Hornet, the "Tomcatters" having changed to the single-seat F/A-18E in late 2006. VF-31 was the last Tomcat squadron, and BuNo. 164603 made the type's final flight on October 4, 2006. The "Tomcatters" are the second oldest active squadron in the Navy.

The small platform contains a group of the carrier's Landing Signal Officers (LSOs), who are responsible for bringing the aircraft aboard the carrier. The LSOs use voice and visual communications to "talk" the pilots aboard, adjusting the aircraft's angle of approach, speed, and level of flight. The LSO holds a small device in one hand, called the "pickle," which controls the Fresnel Lens system that pilots use to judge their approach visually. LSOs present on the platform include squadron and wing level LSOs, and in most cases an LSO-in-training. A squadron LSO can land any aircraft in its squadron; a wing LSO is qualified to land any aircraft in the Carrier Air Wing.

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An F-4J Phantom II from VF-74 "Bedevilers" launches from *Nimitz* during the 1970s. The original island configuration can be seen in the background. (US Navy)

ready rooms, one per squadron, as well as air wing offices and command spaces, berthing, and the "dirty shirt" wardroom. Forward of the ready rooms is what is referred to as "blue tile country" – an area that houses the flag staff, central command, and control suites. As the name implies, this area has blue tile, to designate its command function from other areas of the ship and to restrict personnel traffic.

The following command-and-control facilities are located here:

- Combat Information Center (CIC)/Combat Direction Center (CDC)
- Tactical Flag Command Center (TFCC)
- Ships Signals Exploitation Space (SSES)
- Carrier Air Traffic Control Center (CATCC)

Combat Information Center (CIC)/Combat Direction Center (CDC)

CIC (pronounced *see-eye-see*) serves as the overall combat command facility, overseeing all information whether obtained from ship sensors, aircraft, or from external intelligence sources. CIC, later redesignated CDC to reflect its active warfighting role, has several sub-compartments dedicated to specific warfare missions, including Anti-Surface Warfare (ASuW), Anti-Air Warfare (AAW), Undersea Warfare (USW), and Electronic Warfare (EW). The personnel in each dedicated space manage their own specialty and then forward their information and assessments to the main CDC. These specialized sections are physically separated, which serves to spread out the command functions and limit effects of battle damage on command functions. From the CDC, commanders prosecute the overall battle for the carrier's air wing and the CSG.

Of interest, *Nimitz* and *Dwight D. Eisenhower* were not completed with a USW module; then called ASW, these were added on construction to the *Carl Vinson* and *Theodore Roosevelt* and retrofitted into earlier carriers. These early omissions likely reflect the fact that at the time USS *Nimitz* was designed, the ASW mission was handled by smaller, specially modified *Essex*-class ASW carriers. The ASW mission was merged into the Carrier Air Wing from 1970.

Carrier Air Traffic Control Center (CATCC)

CATCC (pronounced *cat-see*) oversees and coordinates all air operations and air traffic control around the CSG. CATCC is responsible for communicating with all aircraft outside the 5-mile (8km) radius; within that radius, control is handed to the Air Boss in Pri-Fly, and subsequently to the LSO. CATCC, along with the air controllers aboard airborne E-2 Hawkeyes, will be the voices with whom aviators speak during missions.

Ships Signals Exploitation Space (SSES)

Although highly sensitive, the purpose of SSES is to process and exploit electronic signals of interest. Staff members working in SSES have access to national- and theater-level intelligence. SSES is responsible for providing indications and warning support to the tactical watch standers aboard the carrier and to strike group planners, and it provides real-time reporting and

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dissemination of time-sensitive information to national- and tactical-level decision-makers throughout the theater and fleet. All technicians working in SSES have security clearance and are part of the OS Division of the Intelligence Department.

Tactical Flag Command Center (TFCC)
A miniature version of the CIC, this space is where the flag admiral and CSG commander can work to control CSG operations, using a variety of USQ-81(V) 20ft^2 (6.2m^2) large-screen displays for viewing information. TFCC was later added to all classes of supercarriers.

Nimitz-class carrier islands often look very different, reflecting the fact that modifications are constantly being made as each enters overhaul and maintenance periods. The large dome on the mast top is the WSC-6 SHF SATCOM; the small radome forward houses the USQ-123 Tactical Common Data Link (TCDL); the three radomes above Primary Flight Control (Pri-Fly) house (l–r) two USC-38 EHF SATCOM and the Global Broadcast System (GBS). The small antenna facing port is the SPN-43 CCA. (US Navy)

Defensive Systems

US Navy carrier design since the 1950s has steered away from high-caliber weaponry, as designed into the *Forrestal* class, and focused more on missile defense. Moreover, the bulk of the carrier's defense has been left to either its embarked air wing or the other vessels of the CSG. Carriers today normally deploy with an entourage of between three and ten surface combatants, which consist of frigates, destroyers, and cruisers, and typically a nuclear-powered attack submarine.

To illustrate, USS *Abraham Lincoln* deploys as part of CSG Nine, which consists of the carrier, its air wing CVW 2, and the supporting ships within the CSG. At the time of writing, CSG Nine consists of the following ships: the *Ticonderoga*-class cruiser USS *Cape St. George* (CG 71); four *Arleigh Burke*-class destroyers, USS *Halsey* (DDG 97), USS *Sterett* (DDG 104), USS *Shoup* (DDG 86), and USS *Momsen* (DDG 92); and three *Oliver Hazard Perry*-class frigates, USS *Ford* (FFG 54), USS *Rodney M. Davis* (FFG 60), and USS *Ingraham* (FFG 61). Each CSG ship has a primary mission, whether air defense, anti-surface, or anti-submarine warfare. Moreover, the ships are specifically arranged around the carrier as pickets so as to best protect it from anticipated threats.

In addition to these highly capable escorts, the carrier has a limited self-defense capability against airborne and undersea threats that might evade the various pickets. When commissioned in 1975, USS *Nimitz* and sisters *Dwight D. Eisenhower* and *Carl Vinson* each carried three Basic Point-Defense Missile Systems (BPDMS). The original design called for two RIM-24 Tartar missile systems for self-defense. These were replaced with twin 3in/50cal guns, controlled by three Mk 56 fire-control directors, which in turn were replaced by three twin quad 40mm Bofors anti-aircraft guns, and eventually by the BPDMS. The BPDMS used the Mk 25 launcher and eight RIM-7E-5 Sea Sparrow folding-fin missiles, a derivative of the Air Force's AIM-7E. Fire control was obtained using the manually trainable Mk 115 illuminator.

Air defense was enhanced in the early 1980s, including replacement of the manual fire-control system with the automated Mk 91 system (incorporating the Mk 95 X-band radar) and, beginning in 1980, with the addition of the Mk 23 Mod 3 Target Acquisition System (TAS) radar. The

This early view shows the *Nimitz* island configuration during the 1980s. Notable are the lattice aft mast and the absence of any Satellite Communications (SATCOM) radomes. (US Navy)

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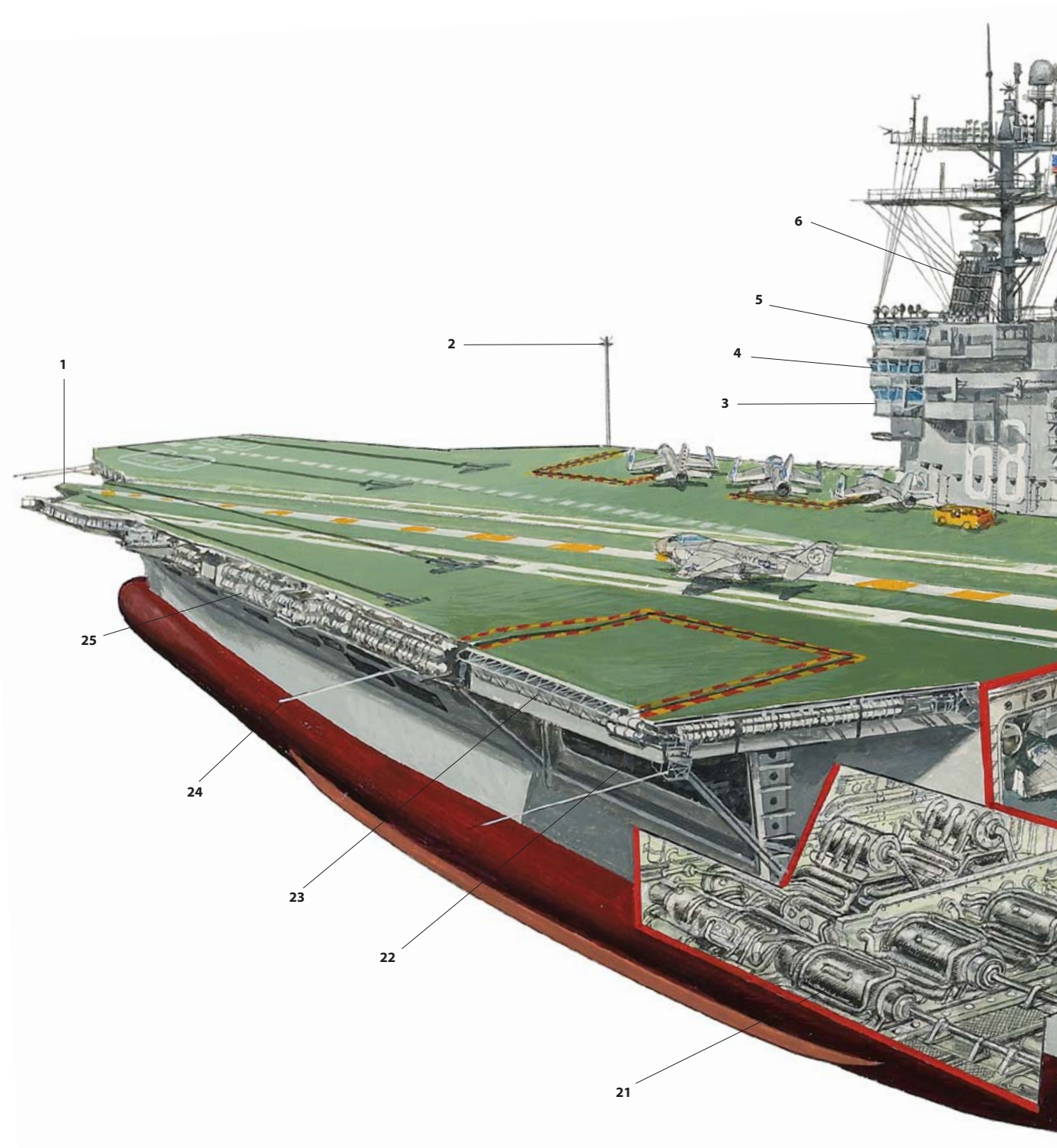

D **USS *NIMITZ* (CVN 68)**

This cutaway illustration shows some of the more significant areas of the *Nimitz*. Although more detailed drawings are classified, this at least shows the basic layout of the hangar bay, elevators, and flight deck. There are ten *Nimitz*-class carriers in the fleet today, the most recent being the USS *George H.W. Bush* (CVN 77), commissioned in January 2009. The *Nimitz*-class carriers displace between 95,000 and 104,000 tons (86,182 and 94,347 tonnes), fully loaded, depending on which carrier one views. The USS *Nimitz*, when launched in 1975, displaced some 77,400 tons (70,216 tonnes), 91,400 tons (82,916 tonnes) fully loaded. A typical *Nimitz*-class carrier has a ship's company of approximately 3,200 personnel and another 2,480 in the air wing. The two Westinghouse A4W nuclear reactors drive four steam turbine engines providing over 260,000shp (194 MW), which can propel the ship at speeds of more than 30 knots (56km/h)

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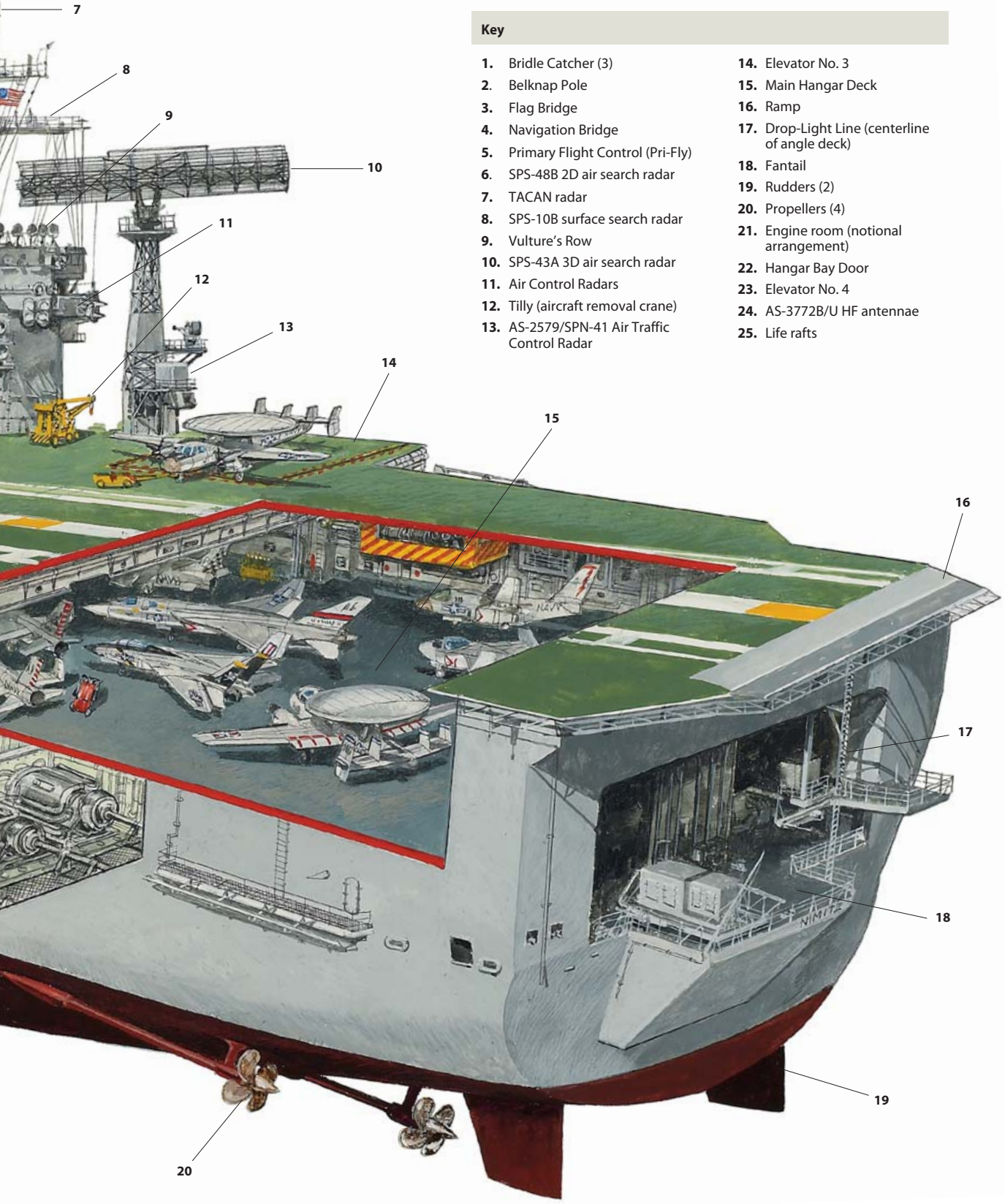

Key

1. Bridle Catcher (3)
2. Belknap Pole
3. Flag Bridge
4. Navigation Bridge
5. Primary Flight Control (Pri-Fly)
6. SPS-48B 2D air search radar
7. TACAN radar
8. SPS-10B surface search radar
9. Vulture's Row
10. SPS-43A 3D air search radar
11. Air Control Radars
12. Tilly (aircraft removal crane)
13. AS-2579/SPN-41 Air Traffic Control Radar
14. Elevator No. 3
15. Main Hangar Deck
16. Ramp
17. Drop-Light Line (centerline of angle deck)
18. Fantail
19. Rudders (2)
20. Propellers (4)
21. Engine room (notional arrangement)
22. Hangar Bay Door
23. Elevator No. 4
24. AS-3772B/U HF antennae
25. Life rafts

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Seen here on a *Ticonderoga*-class cruiser, missile countermeasures on the *Nimitz* carriers are provided by the Mk 36 Super Rapid Blooming Offboard Countermeasures (RBOC) decoy system. The SRBOC can launch chaff or flares to counter incoming missiles. Four of the tubes are positioned at 45 degrees, while the two remaining tubes are at 60-degree angles. The angular device forward of the launcher is the SLQ-32 Electronic Surveillance Measure (ESM) receiver. (US Navy, Daniel Barker)

TAS/Mk 23 is a two-dimensional (2-D) L-band radar that works well against high-speed, low-flying, and high-angle targets and complements the Mk 91 fire control. TAS/Mk 23 has a range of more than 20 nautical miles (37km) and can track 54 targets simultaneously. The BPDMS launch system was also upgraded with the Mk 29 launcher and the more capable RIM-7M missile. The Mk 29 system, called the Improved Point Defense Missile System (IPDMS) or NATO Sea Sparrow, was initially installed on USS *Theodore Roosevelt* and was retrofitted to earlier *Nimitz*-class carriers as they entered maintenance periods. *Nimitz* received the refit during its 1983–84 overhaul and *Dwight D. Eisenhower* during its 1985–87 overhaul. The current missile used is the RIM-9P.

Beginning with USS *Dwight D. Eisenhower* in 2001, the TAS/Mk 23 has been replaced by the Northrop Grumman SPQ-9B X-band multimode, narrow-beam, pulse-Doppler radar for improved efficiency against sea-skimming missiles at the horizon. To date, the SPQ-9B has been installed aboard *Carl Vinson*, *Harry S. Truman*, *Ronald Reagan*, and *George H.W. Bush*.

The 1980s also saw incorporation of the Mk 15 Phalanx Close-In Weapon System (CIWS, pronounced *see-whiz*). CIWS is a pedestal-mounted Mk 61A1 20mm Gatling gun with a self-contained search-and-track radar located in the white dome above the gun. Each unit possesses a 1,000-round drum magazine and can fire at a cyclical rate of 3,000 rounds per minute; each round is radar-tracked, enabling CIWS to make necessary adjustments. The Phalanx first entered service aboard *Enterprise* in 1980, and was installed on *Theodore Roosevelt* during its construction. Units were then retrofitted into earlier *Nimitz*-class carriers. *Nimitz* and *Dwight D. Eisenhower* were refitted with three, while subsequent *Nimitz*-class carriers have four.

CIWS is being replaced by the more capable Raytheon Mk 51 Rolling Airframe Missile (RAM) system. The Mk 51 RAM fires the RIM-116 missile, which combines a modified seeker-head from the Stinger (FIM-92) man-portable surface-to-air missile (SAM) with the proven AIM-9 Sidewinder air-to-air missile (AAM). Missiles are housed in a 21-round rotary launcher. The Mk 51 is highly effective against modern high-speed, sea-skimming threats. First installed aboard *Ronald Reagan* and *George H.W. Bush*, RAM is being retrofitted aboard earlier carriers during maintenance periods. *Nimitz* and *Dwight D. Eisenhower* have had all three Mk 15 Phalanx and one NATO Sea Sparrow launcher replaced by two Mk 51 systems. *George Washington*, *Carl Vinson*, and *Harry S. Truman* have each had a single CIWS and NATO Sea Sparrow launcher removed for the Mk 51. US Navy vessels use the RIM-116B Block I missile, which is an enhanced version featuring both infrared and passive homing capabilities.

Capable of firing 3,000 rounds per minute, the Mk 15 Close-In Weapons System (CWIS) 20mm gun provides close-in defense against incoming missiles. This image shows a test-firing of one of the CIWS units aboard *Harry S. Truman* (CVN 75). (US Navy, Craig R. Spiering)

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Protection against underwater threats is provided by the twin SLQ-25A "Nixie" torpedo countermeasures systems located at the carrier's stern. Introduced in 1987 on *Carl Vinson* and *Theodore Roosevelt*, "Nixie" is a towed noisemaker device that is trailed behind the carrier, when there is a threat of incoming torpedoes, using a fiber-optic tow cable. "Nixie" distracts the torpedo and draws it away from the carrier. SLQ-25B adds a towed torpedo detection array, an SLX-1 Multi-Sensor Torpedo Recognition and Alertment Processor (MSTRAP), and the Launched Expendable Acoustic Decoy (LEAD). LEAD is launched from the Mk 36 decoy system's Mk 137 launcher. An experimental torpedo countermeasures system was trialed on *Nimitz* from 1995 through 2000, with little success. During that time, the carrier was fitted with the SLR-24 towed passive linear torpedo detection sensor as part of the prototype CST-1 torpedo countermeasures system.

Two F/A-18 Super Hornets launch on Catapults Nos. 1 and 3 in the Caribbean Sea as Armada Republica Colombia (ARC) *Caldas* (FM 52) performs plane guard duties. The *George Washington* (CVN 73) was on a maritime training and readiness deployment with various Caribbean and Latin American countries in support of US Southern Command's (SOUTHCOM) maritime security operations. This view highlights the carrier's defensive systems, namely the Mk 29 Sea Sparrow launcher and two Close-in Weapons Systems (CIWS). The large domes near the flight deck are for Satellite Communications (SATCOM). (US Navy, Michael D. Blackwell II)

Additional missile protection is afforded by four Mk 36 Super Rapid Blooming Off-board Countermeasures (RBOC) decoy countermeasures systems. The Mk 36 is a mortar-tube launched decoy containing six 130mm fixed tubes arranged in two parallel rows. The launch tubes (designated Mk 137) are angled at 45 (four tubes) and 60 (two tubes) degrees to obtain optimum spread. Each Super RBOC can launch one of three types of decoys: SRBOC, which uses chaff to defeat RF-emitting missiles and radars; NATO Sea Gnat, which is similar to SRBOC but with extended range and a larger payload; and TORCH, which defeats heat-seeking missiles. Manual reloads are found at nearby Mk 5 Ready Service Stations. Mk 36 launchers are fired from the EW station of the bridge.

Electronic jamming is provided by SLQ-32(V)4 arrays, located port and starboard, which detect and counter active threats from incoming missiles. The SLQ-32(V)4 can also trigger the dispensing of chaff modules, providing a comprehensive Electronic Counter Measure (ECM) response. Early *Nimitz*-class carriers used the less capable SLQ-17, which employed electronic deception and projected a "ghost" image onto which the incoming missile homes. When combined with the WCR-8 Electronic Surveillance Measure (ESM) receiver, the two formed the SLQ-29 suite. The SLQ-32(V)4 began replacing these systems in 1997, first appearing aboard *Theodore Roosevelt*.

The aft port Mk 29 launcher aboard *Theodore Roosevelt* (CVN 71) test-fires a RIM-7 Sea Sparrow missile. (US Navy, Nathan Laird)

Electronic Systems and Radars

Nimitz-class carriers rely on a vast array of radars and electronic sensors during normal and wartime operations. From navigation and instant communications to weapons guidance, *Nimitz*-class carriers are brimming with a variety of radomes, antennas, and radars, most of which are located about the carrier's island structure. Some, like the large 35ft (10.6m) VHF/UHF whip antennas, are located along the edge of the carrier deck.

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The Rolling Airframe Missile (RAM), shown aboard *Harry S. Truman* (CVN 75), is replacing the Close-In Weapons System (CIWS) as the carriers transition through Refueling and Complex Overhaul (RCOH) and refits. Each Mk 51 launcher holds 21 missiles and can be reloaded manually. (US Navy, Ann Marie Lazarek)

Yet another antenna configuration can be seen here on this 1990s view of *Dwight D. Eisenhower* (CVN 69). The two searchlight-like discs on the mast crossbeam are the WSC-3/OE-82 UHF SATCOM antennas. When this photo was taken there were no SATCOM receivers mounted on the forward island. (US Navy)

These antennas are stowed in the horizontal position during flight operations and raised as needed. They are in the process of being eliminated as the early carriers go through RCOH. The most significant systems, those used for surface and air search, navigation, aircraft approach control, and communications, are described below.

Air search

Carriers *Theodore Roosevelt* through *Harry S. Truman* carry the SPS-49(V)5 2-D air search radar, which offers range and bearing information. *Nimitz*, *Dwight D. Eisenhower*, *Carl Vinson*, and *Ronald Reagan* each carry the newer SPS-49A(V)1. *Roosevelt* should receive this variant as it completes its current RCOH. Three-dimensional (3-D) air search radar is provided by the SPS-48C in all class carriers except *George Washington* and *John C. Stennis* (CVN 74), which use the SPS-48E. The SPS-48 provides long-range detection at more than 200 nautical miles (370km) and displays target range, azimuth, and elevation, giving a 3-D picture.

Surface search

Surface search is handled by the C-band (the portion of the electromagnetic spectrum between 500 and 1000 MHz) SPS-67(V)1, a solid-state modular version of the classic SPS-10. All *Nimitz* carriers except *Theodore Roosevelt*, which has a Sperry Raster, use the Furuno 904 navigation radar. The SPS-67 replaced the limited-use SPS-53 and the earlier SPS-10, which was the standard surface search radar when *Nimitz* was commissioned in 1975. The SPS-67 is a medium-range surface search and navigation radar operating in the C-band. Performance of the SPS-67 is enhanced through incorporation of a narrow, 0.1-microsecond pulse mode, creating enhanced resolution and detection. Larger pulses are used for open-ocean navigation. Navigation is also enhanced by the LN-66, BridgeMaster E (BME), and Furuno 904 commercial radars.

Communications

Besides the VHF/UHF whip antennas mentioned earlier, *Nimitz*-class carriers have wide-ranging, sophisticated communications suites that rely heavily on Satellite Communications (SATCOM). *Nimitz* carriers now feature: WSC-3 (UHF); WSC-6 (SHF) for the Defense Satellite Communications System (DSCS); WRN-6 Satellite Signals Navigation Set (GPS); and USC-38 (EHF) for jam-resistant, low-probability-of-intercept secure communications. They also use the SSQ-82; the SSR-1 FM fleet broadcast antennas; WRN-6 GPS receiver; the SRN-9 and SRN-19 Navy Navigation Satellite System (NAVSAT) receivers; and the SMQ-11 receiver for the TIROS-N ocean weather forecasting satellite. Most of the satellite receivers are located in sealed protective domes, where they

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can be environmentally controlled for optimum performance.

A program to utilize a C-band commercial SATCOM system was trialed on *George Washington* in 1993 and has since been adopted on other carriers. Known as Challenge Athena (WSC-8), the system transmits intelligence data, imagery, and shipboard personnel communications, such as Continental US (CONUS) telephone connectivity, video-teleconferencing, and e-mail, and provides direct access to commercial television stations. A new high-speed version, dubbed Challenge Athena III, is being integrated.

This photo shows USS *Dwight D. Eisenhower* (CVN 69) in 2007 following its Refueling and Complex Overhaul (RCOH). An E-2C Hawkeye is parked near the island, as are three SH-60 Seahawks and several deck vehicles, including the large aircraft removal crane, called the "Tilly." The two small radomes on the aft island house the USC-38 EHF SATCOM receivers; the large flat (angled) radar is the SPS-48 3-D air search radar. On the aft island closer to the Tilly are two cone-shaped SPN-46 Aircraft Landing System (ALS) radars. The fence-like projections on the aft island near the top are the ship-to-air AS-4293 sector array UHF communications antennas. (US Navy, Miguel Angel Contreras)

Carrier Controlled Approach (CCA)

Aircraft carriers also rely on a system of radars to control the Automated Carrier Landing System (ACLS) and to monitor and assist aircraft on final approach. Earlier *Nimitz* carriers used a combination of the SPN-35A (X-band carrier-control approach), -41 (microwave providing flight path data), -42 (Ka-band ACLS radar with X-band beacon receiver for marshaling and precision control), and -44 (microwave, used by LSOs) radars; the SPN-43A/B began replacing the SPN-35 by 1996. The SPS-46 replaced the -42, beginning with *Theodore Roosevelt*. This system has a pair of antennas oriented aft that assist aircraft on short final approach. All *Nimitz*-class carriers rely on the URN-25 TACtical Air Navigation (TACAN) homing signal beacon to aid aircraft in locating the carrier.

USS *Carl Vinson* (CVN 70) transits the Pacific Ocean en route to a six-month deployment to the Western Pacific (WestPac) and Arabian Gulf. Visible on the starboard side of the bow are the 35ft (10.7m) VHF/UHF whip antennas, which are raised to the vertical when the carrier is not conducting flight operations. (US Navy, Daniel Smith)

Integrated Air Defense

Recent attempts have been made to add an integrated air defense radar system to assist in protecting the carriers from incoming threats. Made by Raytheon, the Ship Self-Defense System (SSDS) links together existing sensors, such as the SPS-49 and SPS-67 radars, SLQ-32, and Mk 36 decoy launch system, with weapons systems, such as Phalanx, BPDMS, and Mk 51 RAM, to form an organic integrated air defense system. *Dwight D. Eisenhower* received the first version of SSDS, known as the Advanced Combat Defense System (ACDS), in 1998. *Nimitz* received the SSDS Mk 2 Mod 1 installation during 2001. The same system is also found on *Ronald Reagan*.

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A more advanced integrated air defense system is also planned for *Ronald Reagan* and *George H.W. Bush* under the moniker Project Akcita, which incorporates elements of multi-function radar, the Evolved Sea Sparrow Missile (ESSM), and the Advanced Integrated Electronic Warfare System (AIEWS). A D-band radar, Project Akcita will incorporate monolithic microwave integrated-circuit technology and will be able to track more than 1,000 targets out to ranges of over 245 miles (400km). It will incorporate and supersede the SSDS.

Additionally, a new and comprehensive integrated system, referred to as the USG-2 Cooperative Engagement Capability (CEC), is being installed aboard earlier *Nimitz*-class carriers, which coordinates sensors and weapons systems from the entire CSG, including carrier-based aircraft, land-based P-3 Orions and P-8A Poseidons, Aegis-equipped ships, and major amphibious warships. *Dwight D. Eisenhower* underwent trials with the USG-1 version CEC in late 1994 and the USG-2 version was installed during 2000–02. CEC interaction is crucial to the E-2D Advanced Hawkeye platform – equipped with the USG-3 version – set to join the fleet in 2013.

The Carrier Air Wing (CVW)

Since the beginning of carrier aviation, the carrier's offensive punch has come through its embarked air wing. The Carrier Air Wing (CVW) contains a mix of aircraft designed to provide the carrier's offensive capability, plus defensive assets for protecting the CSG, and a host of special-purpose support aircraft. When the *Nimitz*-class entered service, each carrier had two squadrons of fighter aircraft, first F-4 Phantoms and later F-14 Tomcats, and three squadrons of attack aircraft – two light-attack squadrons operating the A-7 Corsair II and one medium-attack squadron operating the A-6E Intruder. Intruder squadrons also performed organic aerial refueling services through their "buddy stores" – aerial refueling systems (ARS) – and with four KA-6D tankers (the Intruders were retired in 1996, along with the all-weather attack mission). Together, these squadrons formed the core of the carrier's offensive strike force. Tomcats, with their long-range AIM-54 Phoenix missiles and AWG-9 radar, also provided fleet defense against missile attacks from long-range Soviet bombers.

The remaining aircraft operated in a support role, providing airborne early warning and airborne tactical jamming, as well as anti-submarine support. The E-2 Hawkeye, which entered operational service in 1965, served

Two squadrons of F-14D Tomcats are positioned for launch for their fly-off from USS *Theodore Roosevelt* (CVN 71) to Naval Air Station Oceana in March 2005. VF-213 and VF-31 had just completed their final deployment flying the F-14. Although designed as a long-range interceptor, the Tomcat evolved into a highly capable ground-attack aircraft and also flew photo reconnaissance. (US Navy, Chris Thamann)

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as the fleet's "eye in the sky," with its revolving radome giving the battlegroup commander a full aerial picture for hundreds of miles around the carrier. EA-6B Prowlers accompanied the strike packages, offering electronic jamming and emitter localization of enemy radars and SAM sites. From 1984, Prowlers often carried AGM-88 HARM anti-radiation missiles for taking out enemy radars. ASW support was provided by helicopters and, after 1975, the Lockheed S-3 Viking, which was deployed in Air ASW (VS) squadrons. ASW assets would use a combination of sensors, including sonobuoys, surface search radar, and a Magnetic Anomaly Detector (MAD), to detect, localize, and classify submarines, and prosecute attacks using torpedoes or depth bombs.

Just ten days after the start of Operation *Enduring Freedom*, Tomcats and Hawkeyes aboard *Theodore Roosevelt* (CVN 71) stand ready for missions over Afghanistan. The carrier's aft mast has the SPS-49 2-D air search radar. (US Navy, Jason Scarborough)

The air wing composition has changed significantly since *Nimitz*'s initial 1975 cruise. On that cruise, which lasted from July 16 through September 24, *Nimitz* deployed with Carrier Air Wing Eight (CVW 8), which consisted of fighter squadrons VF-31 and VMFA-333 (F-4J Phantom II), light-attack squadrons VA-82 and -86 (A-7E Corsair II), medium-attack squadron VA-35 (A-6E Intruder; KA-6D tanker), an early warning squadron, VAW-116 (E-2B Hawkeye), and an electronic warfare squadron, VAQ-130 (EA-6B Prowler). ASW was provided by HS-15's SH-3D Sea Kings. Reconnaissance aircraft (RF-4C or RA-5C Vigilante) and electronic surveillance aircraft (EA-3B Skywarriors or Whales) were carried in two-plane detachments. The photo-reconnaissance mission was later assumed by one of the two embarked Tomcat squadrons using the Tactical Reconnaissance Pod System (TARPS).

The "conventional" air wing composition described above governed for much of the 1970s and 1980s, with the Corsair II being replaced by the Hornet in the mid-to-late 1980s. During the 1990s, the phasing out of the Intruder saw further changes to the CVW, with carriers deploying with one fighter squadron of Tomcats and three or four squadrons of dual-purpose strike-fighter F/A-18 Hornets. The VS squadrons, which assumed the tanking role from the retired Intruders, continued service until 2008 when the final squadron, VS-22, was deactivated.

Current air wing composition typically consists of 44 strike aircraft – two 11-plane squadrons of F/A-18E/F Super Hornets (one -E and one -F), and two 11-plane squadrons of F/A-18A/C Hornets (one of which might be a US Marine Corps squadron); a squadron of four EA-6B Prowlers; a squadron of four E-2C Hawkeyes; and seven SH-60F/HH-60H Seahawks. The F-35 Lightning II Joint Strike Fighter (JSF), expected to join the fleet in 2015, will replace older F/A-18Cs and complement the Super Hornet. From 2010 the EA-6B is being replaced by the EA-18G Growler, a derivative of the Block II F/A-18F Super Hornet. Also, the E-2D Advanced Hawkeye will replace the E-2C Hawkeye 2000 aircraft, starting in 2014. MH-60R/S Seahawks have already begun replacing

An EA-6B Prowler is seen here aboard *Theodore Roosevelt*, as is the LSO platform at the bottom of the image. The small cylinders are 25-person life rafts. (US Navy, Jonathan Snyder).

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Each carrier has a small squadron of helicopters for Anti-Submarine Warfare (ASW), Search-and-Rescue (SAR), and underway Vertical Replenishment (VERTREP). Here, an SH-60S Seahawk helicopter belonging to HSC-26 lands aboard *Carl Vinson* (CVN 70). Approaching aircraft used the Fresnel lens (port side) to maintain proper glide slope. (US Navy, Joshua Johnson)

older SH-60B, -F, and HH-60H helicopters as part of the newly formed Helicopter Sea Combat (HSC) and Helicopter Maritime Strike (HMS) squadrons, and made their first deployment in January 2010 aboard USS *John C. Stennis*.

The air wing is led by a captain, called the Commander, Carrier Air Wing, but still referred to as "CAG," from the time when air wings were called Carrier Air Groups. CAG is considered a major command position and may be held by either an aviator or naval flight officer (NFO). Typical tour lengths are 18 months.

Propulsion and Powerplant

The powerplant for the *Nimitz*-class carriers is located on the Fourth Deck and is under heavy security. Although the details of their powerplants are largely classified, the *Nimitz*-class carriers are powered by two Westinghouse A4W reactors, each providing enough steam to generate 140,000shp (104 MWe). The A2W reactor was used in USS *Enterprise*, which had eight, while the A3W was the reactor intended for USS *John F. Kennedy*, when plans called for a nuclear propulsion unit. The reactor cores for *Nimitz* and *Dwight D. Eisenhower* are estimated to have an operational life of 13 years, with those for *Vinson* and the remaining class carriers estimated at 15 years.

The A4W reactors heat pressurized water, which in turn heats a separate water loop and turns it into high-temperature, high-pressure steam. The steam drives the ship's four main-propulsion turbines, generators, and auxiliary

E

EA-6B PROWLER READIES FOR LAUNCH FROM USS *HARRY S. TRUMAN* (CVN 75)

An EA-6B Prowler from VAQ-130, the "Zappers," prepares for launch from the USS *Harry S. Truman* (CVN 75) in mid-2007. The electronic warfare squadrons provide electronic and communications jamming for strike packages as they ingress and egress targets, and also use their elaborate passive sensors to develop an Electronic Order of Battle (EOB) that identifies, locates, and classifies hostile emitters. Although Prowlers can carry up to five ALQ-99 Tactical Jamming System (TJS) pods, which operate on specified frequencies, this EA-6B carries two ALQ-99 pods and three fuel tanks. The small propellers located on the front end of the ALQ-99s are ram-air turbines, which provide the power for the electronics carried within the pods. A typical VAQ Tactical Electronic Warfare squadron deploys with four or five Prowlers. The Prowler, which first deployed in July 1971, is being replaced by the EA-18G Growler.

The Prowler here is being prepared to launch from bow Catapult No. 2. At this point in the process, the Jet Blast Deflector (JBD) has been raised and the aircraft is hooked to the catapult system via the tow bar (visible just ahead of the front landing gear) and holdback system. The large radiation emblem located on the nose radome serves to distinguish the aircraft readily from the A-6E Intruders. The two aircraft had different weights, and the emblem quickly distinguished the two for deck personnel for launch and recovery operations.

The *Harry S. Truman* is the eighth *Nimitz*-class carrier and was commissioned in 1998. Homeported in Norfolk, Virginia, it regularly deploys to the North Atlantic, Mediterranean Sea, and Persian Gulf/Indian Ocean. The carrier received the prestigious Battle Efficiency "E" award three consecutive years, from 2003 to 2005, and was designated as the most battle-ready ship in the Atlantic Fleet in 2004.

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The massive propeller blades of the USS *George H.W. Bush* (CVN 77) are seen here, redesigned from earlier *Nimitz*-class carriers to reduce wear. These propellers are being retrofitted on earlier carriers during their Refueling and Complex Overhaul (RCOH) (Northrop Grumman Shipbuilding Newport News).

machinery, and also provides steam for the four catapults. Power is channeled into four 462ft (140.8m) propeller shafts, each 2ft (0.6m) in diameter and weighing more than 364 tons (330.21 tonnes), which drive four 22ft (6.71m) diameter five-bladed brass propellers, each weighing more than 30 tons (29.93 tonnes). Each shaft is so large that it must be installed in seven sections.

Navigational control is provided by two rudders, each weighing 50 tons (45.4 tonnes) and measuring 29ft (8.84m) in height. *Nimitz*-class carriers are officially listed as having a top speed of 30 knots (56km/h), but its true speed remains classified. The reactor is overseen by the Reactor Department, which can have as many as nine divisions, including specialized damage control, which on some carriers is designated as the RXDC Division. The department is headed by the reactor officer, normally a commander.

OPERATIONAL HISTORY

With the commissioning of the USS *George H. W. Bush* in 2009, the last of the *Nimitz*-class carriers has joined the fleet. Although technically a *Nimitz*-class carrier, *George H.W. Bush* and its predecessor *Ronald Reagan* incorporate several new features, such as the bulbous bow and modified island, which will eventually appear in the *Gerald R. Ford*-class.

Carrier Homeports

EAST COAST/ATLANTIC FLEET	WEST COAST/PACIFIC FLEET
Norfolk, VA	Bremerton, WA
Dwight D. Eisenhower	*John C. Stennis*
Theodore Roosevelt (RCOH)	*Nimitz*
Harry S. Truman	
George H.W. Bush	Everett, WA
Enterprise	*Abraham Lincoln*
Gerald Ford (under construction)	Coronado, CA
	Ronald Reagan
	Carl Vinson
	Yokosuka, Japan
	George Washington

Nimitz-class carriers undergo a complex maintenance and servicing process. The most significant of these is the 33-month Refueling and Complex Overhaul (RCOH), which occurs after 25 years of service. During this period, the carrier is refurbished, and its nuclear fuel replaced. Major changes in combat systems, defensive weapons, computer networks, and crew quarters are also accomplished. *Nimitz* was the first to enter RCOH, from May 1997 through June 2001. *Dwight D. Eisenhower* underwent its $2.5 billion RCOH from May 2001 through March 2005, and *Carl Vinson* from November 2005 through early 2009. In late 2009, *Theodore Roosevelt* entered the yard to

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begin its RCOH period, which should be completed in February 2013. Its RCOH is the first scheduled for 39 months, reflecting the elimination of the typical follow-on Selective Restrictive Availability (SRA, a limited maintenance period during which upgrades and modernization take place) by incorporating those tasks into the RCOH. *Abraham Lincoln* will then follow. Carriers leaving RCOH undergo sea trials before they are redelivered to the fleet.

USS *Dwight D. Eisenhower* (CVN 69), in the foreground, cruises just astern of the USS *Harry S. Truman* (CVN 75) as the latter carrier undergoes replenishment at sea. (US Navy via NavSource)

For new carriers, there are usually two sea trials before the ship is delivered to the Navy. The first trial is a "Builder's Trial," in which the carrier ship goes to sea, usually for three to four days, and conducts at-sea operations, demonstrating that the ship operates to contracted specifications. The second trial is an "Acceptance Trial"; this at-sea period, which lasts about the same time as the Builder's Trial, is conducted by the Navy's Independent Board of Inspections and Surveys (INSURV) and confirms the carrier and crew are "ready for sea." Once discrepancies are resolved, INSURV "signs off" and the Navy accepts delivery. After the traditional commissioning ceremony, the carrier begins a series of short at-sea periods during which the flight deck is certified for operations. The carrier then returns to port for a Post Shakedown Availability (PSA), in many ways like a "warranty check" provided for a new car. System upgrades, and at times, new equipment, are also handled during a PSA.

During most of the 1980s through the early 2000s, the carriers and their attached air wings operation under the Inter-Deployment Training Cycle (IDTC), which saw deployments of up to six months followed by 18-month training cycles between cruises or deployments. The pre-deployment aspects of the IDTC were divided into three phases – basic, intermediate, and advanced – and grew in complexity the closer the carrier and air wing moved towards deployment. Basic training focused on the individual units, whether ships or squadrons, and intermediate training involved combined or composite training, which brought all units of the battle group together. The advanced phase took this training one step further and integrated joint training with other services and advanced battle group employment tactics. Under the IDTC, two or three carriers were typically deployed at any one time, three or four were in pre-deployment work-ups, and two were in various stages of maintenance or repairs. One was typically in overhaul. Another carrier was forward-deployed in Japan. According to the Navy,

> The IDTC is more commonly known now as the Fleet Response Training Plan (FRTP), which is the training period associated with the Fleet Response Plan (FRP), designated to provide improved response to combatant comer requests for forces. The deployment cycle has changed in the past four-to-five years, with carrier strike groups sometimes deploying for time periods of greater than six months and often deploying multiple times within an 18-month or two-year period. Some strike groups deploy for five or six months, followed by a five- or six-month period at home, and then deploy again. The traditional cycle of a six-month deployment followed by eighteen months or so in training does not occur as often as in years past. Where there is longer training (12 months or greater) for a turn-around cycle, the training is divided into a maintenance phase, a basic phase, and an integrated training phase. Integrated training included air wing detachments to NAS Fallon and at-sea training with the carriers and their escorts.

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USS *Ronald Reagan* (CVN 76) and guided missile destroyer USS *Paul Hamilton* (DDG 60) perform "fueling at sea" (FAS) operations. *Reagan*'s larger mast is clearly visible. The ability to refuel and replenish at sea is crucial for carrier operations conducted over wide geographic areas. (US Navy, Spike Call)

One of the primary purposes of the FRP is to permit "surge" deployments, in effect maximizing the number of Carrier Strike Groups that could be deployed in a crisis. *Summer Pulse* 2004 was the first surge exercise, demonstrating the Navy's ability to rapidly deploy seven carriers in a short timeframe. Four *Nimitz*-class carriers and their Strike Groups participated in this exercise – *George Washington*, *John C. Stennis*, *Harry S. Truman*, and *Ronald Reagan*.

THE CARRIERS

All *Nimitz*-class carriers were built at Northrop Grumman Shipbuilding Newport News (NGSB-NN) located in Newport News, Virginia. Owned by Northrop Grumman, this is the sole shipbuilding facility in America capable of building large carriers. Construction processes have changed since the keels were laid for *Nimitz*, *Dwight D. Eisenhower*, and *Carl Vinson*, each of which was built using conventional "build-up" shipbuilding techniques, assembling the ship from keel up in the same engraving dock that built the *Forrestal* carriers. Beginning with *Theodore Roosevelt*, construction techniques changed to a modular approach that is still used today, whereby sections are constructed as individual "Super Lifts," and then joined to the hull in dock.

USS *Nimitz* (CVN 68)

USS *Nimitz* (CVN 68)	
Funding authorized	Fiscal Year 1966
Keel laid	June 22, 1968
Launched	May 13, 1972
Commissioned	May 3, 1975
Nickname	*Old Salt*

Named for Fleet Admiral Chester Nimitz, Commander-in-Chief of the Pacific Fleet during World War II, CVN 68 is the lead ship of the class and

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is expected to serve until 2024. *Nimitz* is perhaps the most widely recognized carrier of the class, its F-14As having successfully downed two Libyan fighters in 1981 in the Gulf of Sidra and having been featured in the 1980 movie *The Final Countdown*. *Nimitz* was also in the recent PBS documentary *Carrier*. Part of CSG 11, *Nimitz* has participated in Operation *Southern Watch* and flown missions directly supporting recent anti-terrorism missions over Iraq and Afghanistan. In 2005, its air wing flew more than 1,100 sorties and clocked up 6,000 flight hours supporting Operation *Iraqi Freedom*. During that same cruise, *Nimitz* became the first carrier to deploy the new F/A-18F Super Hornet and the E-2C Hawkeye 2000. *Nimitz* completed its 20th deployment in July 2010.

TOP
An older image shows USS *Nimitz* (CVN 68) still sporting the original truss tower. This photo clearly shows the location of the two forward elevators and shows three Tomcats and a Hornet being positioned on the bow catapults for launch. (US Navy)

BELOW
Carrier air operations create one of the most dangerous work environments in the world. Here, *Nimitz* (CVN 68) prepares for an event launch in April 2003 in support of Operation *Iraqi Freedom*. (US Navy, Elizabeth Thompson)

USS *Dwight D. Eisenhower* (CVN 69)

USS *Dwight D. Eisenhower* (CVN 69)	
Funding authorized	Fiscal Year 1970
Keel laid	August 15, 1970
Launched	October 11, 1975
Commissioned	October 18, 1977
Nickname	*Ike*

Named for the 34th President of the United States and a five-star general of the US Army, the carrier was originally named simply *Eisenhower;* in May 1970 it was renamed *Dwight D. Eisenhower*. The carrier was fitted

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Seen after Refueling and Complex Overhaul (RCOH), USS *Dwight D. Eisenhower* (CVN 69) and embarked Carrier Air Wing Seven (CVW 7) are participating in a Composite Training Unit Exercise (COMPTUEX) in the Atlantic. Visible on the port side near the "crotch" is one of the Mk 51 Rolling Airframe Missile (RAM) launchers. (US Navy, Miguel A. Contreras)

with CIWS, NATO Sea Sparrow, and an ASW command module during its 1985–89 RCOH. In 1990, during Operation *Desert Shield*, *Dwight D. Eisenhower* became the second nuclear-powered carrier ever to transit the Suez Canal, and it was the first carrier modified for female air crew members. In 1994, its air wing was disembarked and replaced with troops and helicopters of the US Army's 10th Mountain Division in preparation for possible action in Haiti. At the time of writing *Dwight D. Eisenhower* has made 15 deployments.

USS *Carl Vinson* (CVN 70)

USS *Carl Vinson* (CVN 70)	
Funding authorized	Fiscal Year 1973
Keel laid	October 11, 1975
Launched	March 18, 1980
Commissioned	February 25, 1982
Nickname	*Chuckie V*; *Battlestar*; *Gold Eagle*

Carl Vinson was a member of the US House of Representatives for 50 years, and for 29 years served as the Chairman of the House Naval Affairs and Armed Services Committee. *Carl Vinson*'s service began with a world cruise in 1983 and in 1985 some of its F-14A Tomcats participated in the filming of the movie *Top Gun*. In 1999, *Carl Vinson*'s embarked CVW 11 flew air operations in support of Operation *Southern Watch* over southern Iraq, logging 8,698 sorties and 17,398 flight hours, with a 94.7 percent mission completion rate. It was one of the two carriers in December 1998's Operation *Desert Fox* strikes on Iraq, and it launched the first air strikes of Operation *Enduring Freedom*, commencing on October 7, 2001. *Carl Vinson* left RCOH in 2009 and rejoined the Pacific Fleet, based out of San Diego, in

Carl Vinson (CVN 70) performs high-speed turns during the rudder check phase and sea trials certification in July 2009. (US Navy, Justin Stumberg)

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mid-2010. The carrier has made 12 deployments since 1983. As part of its RCOH, the carrier received new propellers, which were redesigned to reduce wear and erosion. These were installed on *George H.W. Bush* and will be standard on all *Nimitz*-class carriers.

USS *Theodore Roosevelt* (CVN 71)

USS *Theodore Roosevelt* (CVN 71)	
Funding authorized	Fiscal Year 1980
Keel laid	October 13, 1981
Launched	October 27, 1984
Commissioned	October 25, 1986
Nickname	*TR; Big Stick*

Because of the modifications made to the next *Nimitz*-class carrier, USS *Theodore Roosevelt* has been referred to as an improved *Nimitz*-class and, in some literature, a separate sub-class. Financial authorization for the carrier was delayed for several years while political and military leaders debated the merits of a smaller nuclear carrier, dubbed the CVV design, or building a compromise repeat of the conventional *John F. Kennedy* design. Both proposals were eventually rejected as inferior and *Roosevelt* was authorized in FY 1980.

One of the most active of the class, *Theodore Roosevelt* has seen action in Operations *Desert Storm* and *Allied Force* over Bosnia and Kosovo, and Operations *Iraqi Freedom* and *Enduring Freedom*. With CVW 8 embarked, *Theodore Roosevelt* aircraft flew more than 4,200 sorties during *Desert Storm*, more than any other carrier, and dropped over 4.8 million pounds (2.1 million kilograms) of ordnance. The ship also holds the honor of being the last carrier to operate the venerable F-14 Tomcat. On their last cruise supporting *Iraqi Freedom*, the F-14s of VF-31 and -213 flew 1,163 combat sorties in 6,876 flight hours, and dropped more than 9,500lb (4,318kg) of ordnance. The carrier entered RCOH at Newport News in late 2009 and will rejoin the fleet in 2012. It has made 11 deployments by the time of writing, many of which saw combat.

BELOW LEFT
An approaching pilot's view of the angled portion of the USS *Theodore Roosevelt* (CVN 71) flight deck. (US Navy, Michael D. Cole)

BELOW RIGHT
An F-14D launches from the *Roosevelt*'s waist Catapult No. 4. Because of deck clearance issues, No. 4 catapult cannot launch aircraft at full weight. This limitation has been remedied in the *Ronald Reagan* (CVN 76) and beyond. (US Navy, Chris Thamann)

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USS *Abraham Lincoln* (CVN 72)

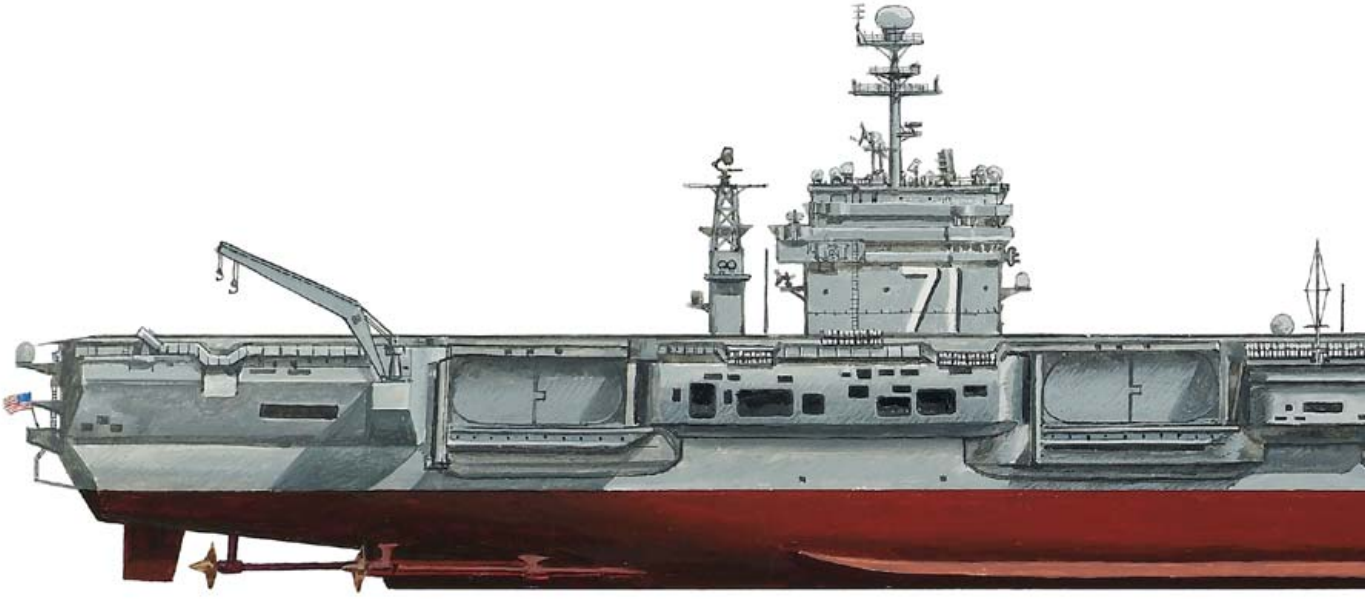
USS *Abraham Lincoln* (CVN 72)	
Funding authorized	Fiscal Year 1983
Keel laid	November 3, 1984
Launched	October 24, 1987
Commissioned	November 11, 1989
Nickname	*Abe*

Named in honor of the 16th President of the United States, *Abraham Lincoln* was the second US Navy ship to bear the name (SSBN 602, 1961–81). The carrier began its maiden cruise four months early in order to support post-*Desert Storm* air operations. It was the first to make the complete integration of female aviators following the lifting of the Title 10 restrictions in 1994, and later that

F

USS *THEODORE ROOSEVELT* (CVN 71)

Commissioned on October 25, 1986, the USS *Theodore Roosevelt* (CVN 71) is sometimes referred to as a *Nimitz* sub-class, largely due to the significant modifications that were incorporated into its design. Moreover, the *Roosevelt* was the first *Nimitz*-class carrier built using the Super Lift system, rather than the traditional keel-up construction techniques used for all previous ships. This process cut 16 months off the carrier's anticipated construction schedule. The carrier's maiden deployment also marked the first time that ten squadrons had been deployed as part of a Carrier Air Wing. *Roosevelt* saw its first combat in 1991, during Operation *Desert Storm*, where its air wing, CVW 8, posted more sorties than any other carrier in the war. *Roosevelt* also saw extensive action in support of Operation *Allied Force* in the Adriatic Sea in 1999 and in the recent *Enduring Freedom* and *Iraqi Freedom* operations.



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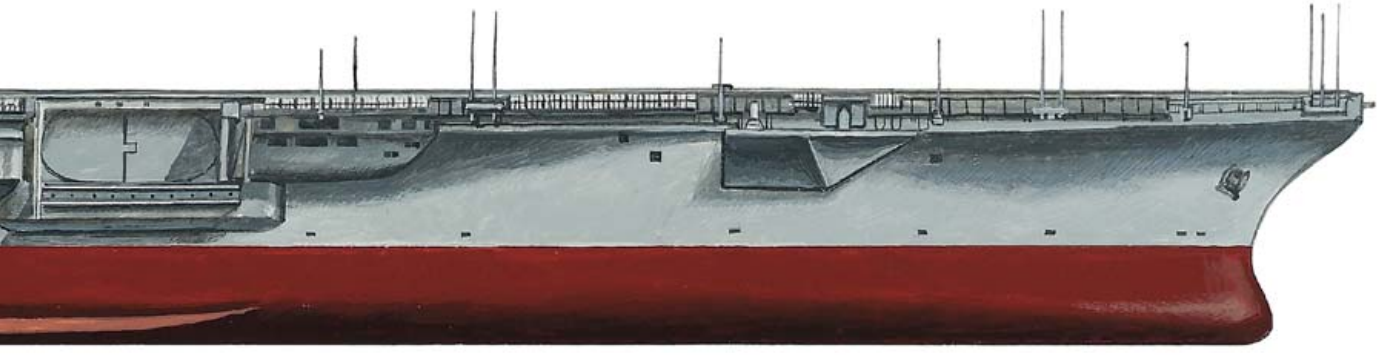
year was the first Carrier Air Wing to deploy without F-14s or S-3Bs. It was also the first carrier to deploy with SH-60B Seahawks, which are typically assigned to surface combatants. *Lincoln* participated in *Valiant Shield* 2006, a major fleet exercise off Guam combining three CSGs – those of *Ronald Reagan*, *Kitty Hawk*, and *Abraham Lincoln*. In May 2003, the carrier became the first to have a sitting President, then-President George W. Bush, make an arrested landing. President Bush arrived in an S-3B *Viking* from VS-35 "Blue Wolves," designated as "Navy One". *Lincoln* has made nine deployments since its commissioning.

USS *George Washington* (CVN 73)

USS *George Washington* (CVN 73)	
Funding authorized	Fiscal Year 1983
Keel laid	August 25, 1986
Launched	July 21, 1990
Commissioned	July 4, 1992
Nickname	*The Spirit of Freedom; GW; G-Dub*

The last of the so-called Presidential Mountain carriers, *George Washington* celebrated its maiden deployment by participating in activities marking the 50th anniversary of the D-Day landings. This carrier deployment was also the first for women permanently assigned to a carrier crew. In 2003, the carrier deployed to the Indian Ocean and Persian Gulf, where its embarked air wing, CVW 7, supported Operations *Enduring Freedom* and *Iraqi Freedom*. During its 2006 Planned Incremental Availability (PIA) maintenance period, the carrier received a new main mast and had one CIWS and one NATO Sea Sparrow launcher replaced by Mk 51 RAM launchers; the TAS/Mk 23 was also replaced with the SPQ-9 fire control. *George Washington* was



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An E-2C Hawkeye from VAW-124 performs a fly-by maneuver over USS *George Washington* (CVN 73). The carrier was en route to Yokosuka, Japan, where it replaced *Kitty Hawk* (CV 63). The large hangar bay openings are visible. The carrier's aft radar tower is enclosed, which differs from earlier *Nimitz*-class carrier design. (US Navy, Clifford L. H. Davis)

commissioned with its hangar bay bulkhead and overhead painted white, rather than gray, to make it seem brighter and larger. All other carriers have followed suit. In recognition of its namesake's prestige as the first US President, *Washington* is also the only carrier to have its island number outlined in red, white, and blue lights. *George Washington* has made 11 deployments and was deployed to the waters off New York City following the 9/11 attacks. In 2008, the carrier was forward-deployed to Japan where it is now stationed.

USS *John C. Stennis* (CVN 74)

USS *John C. Stennis* (CVN 74)	
Funding authorized	Fiscal Year 1988
Keel laid	March 13, 1991
Launched	November 11, 1993
Commissioned	December 9, 1995
Nickname	*Johnny Reb*

CVN 74 was named in honor of Senator John Cornelius Stennis (Democrat, Mississippi), who served in the US Senate from 1947 to 1989. The carrier made a "round the world cruise" on its maiden voyage, leaving Norfolk, VA, in February 1998 and arriving in San Diego on August 26. *John C. Stennis* made the 22,078-nautical-mile (40,888km) voyage in 923 hours,

USS *John C. Stennis* (CVN 74) is seen here in 2006 somewhere in the Pacific Ocean. The large radome houses the WSC-6 SHF Satellite Communications (SATCOM) antenna. (US Navy, Paul J. Perkins)

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averaging a speed of 24 knots (44km/h). Working with CVW 9, the carrier was the first to launch air strikes supporting Operation *Anaconda* in Afghanistan in March 2002. It spent 111 days on the line during Operation *Enduring Freedom* in the same year, with the air wing flying 10,600 sorties and clocking up more than 54,000 flight hours. On September 6, 2005, *John C. Stennis* entered a scheduled Docketed Planned Incremental Availability (DPIA), where it received a new mast and had a CIWS and NATO Sea Sparrow replaced by two Mk 51 RAMs. On June 18, 2007, an F/A-18F from VFA-154 marked the carrier's 100,000th arrested landing. Later that year, the carrier became the first to fire successfully an ESSM RIM-162 D-1 during a Combat Systems Ship's Qualifications Trials. *John C. Stennis* has made six deployments since its commissioning in 1995.

USS *Harry S. Truman* (CVN 75)

USS *Harry S. Truman* (CVN 75)	
Funding authorized	Fiscal Year 1988
Keel laid	November 29, 1993
Launched	September 7, 1996
Commissioned	July 25, 1998
Nickname	*HST*

The massive size of the flight deck can be seen in this overhead view of USS *Harry S. Truman* (CVN 75). A row of F/A-18Fs is parked along Catapult No. 2 in an area known as the Four Row, while a Hawkeye sits on Catapult No. 1. (US Navy, Jay C. Pugh via NavSource)

Originally authorized as the *United States*, the *Harry S. Truman* was renamed in February 1995 at the direction of then-Secretary of the Navy John H. Dalton. Just two years after commissioning, *Truman* was in combat off the coast of Iraq supporting no-fly zones. In 84 days of operations, the carrier's embarked air wing, CVW 3, flew 869 sorties and logged 2,700 flight hours, including four strikes against Iraqi targets. In 2005, the carrier provided assistance for Hurricane Katrina rescue operations in the Gulf of Mexico and on August 5, 2009, it hosted the initial carrier qualifications for the new EA-18G Growlers of VAQ-129 and VAQ-132.

Truman underwent a $110 million six-month overhaul at Newport News beginning February 26, 2002, and completed a nearly seven-month PIA at the Norfolk Naval Shipyard in February 2009 and at the time of writing is on deployment. The carrier has been featured in the Discovery Channel documentary, *City of Steel*. *Truman* was the first in the class to receive the IT-21 intranet network and WSC-6 SHF SATCOM receiver. The carrier has made a total of five deployments.

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USS *Ronald Reagan* (CVN 76)

USS *Ronald Reagan* (CVN 76)	
Funding authorized	Fiscal Year 1994
Keel laid	February 12, 1998
Launched	March 10, 2001
Commissioned	July 12, 2003
Nickname	*The Gipper*

Named for the 40th US President, USS *Ronald Reagan* has made five deployments. Several weather-related problems and a circuit breaker fire caused a short delay in the carrier's delivery. Unlike earlier *Nimitz*-class carriers, *Reagan* has only three arresting wires. The carrier also features the more advanced SPS-48E 3-D and SPS-49A(V)1 2-D air search radars. Instead of having the standard V-shaped bow like its predecessors, *Ronald Reagan* has a bulbous bow.

During the carrier's 2009 deployment, aircraft from its embarked Air Wing 14 flew more than 1400 sorties in support of Operation *Enduring Freedom*. The first sorties were launched on July 6 from the carrier's station in the northern Arabian Sea. The *Ronald Reagan* has recently completed a Planned Incremental Availability (PIA) maintenance period at Naval Air Station North Island, and is preparing for deployment in late 2010.

USS *George H.W. Bush* (CVN 77)

USS *George H.W. Bush* (CVN 77)	
Funding authorized	Fiscal Year 2001
Keel laid	September 6, 2003
Launched	October 7, 2006
Commissioned	January 10, 2009
Nickname	–

G

USS *RONALD REAGAN* (CVN 76)

As with the *Theodore Roosevelt* (CVN 71), the USS *Ronald Reagan* (CVN 76) marks another departure in the class line. With its flight deck modifications (relocated weapons elevators and more flight deck space), modified island structure, and bulbous bow section, the *Ronald Reagan* represents the first step towards the next-generation carriers, the *Gerald R. Ford* class. Indeed, the new composite mainmast, relocated aft mast, and new topside antennas arrangement make USS *Ronald Reagan*'s island structure markedly different from previous carrier islands. In addition, the island has one fewer deck, yet maintains the same overall height, which makes for more interior room and space for future technology, plus larger windows for improved visibility.

The method of construction of the island changed as well. On previous carriers, the islands were built in two large sections next to the dry dock, then joined together and lifted onto the ship. On *Reagan*, the island was assembled in its entirety, then transported as one large section to the dry dock. Moreover, the island was designed using the new 3-D computer modeling, which later designed portions of the *George H.W. Bush* and the entirety of the PCU (Pre-Commissioning Unit) *Gerald R. Ford*. The *Reagan*'s bulbous bow design is also a departure from prior *Nimitz*-class carriers. Weighing some 722 tons (655 tonnes), the bow adds greater stability than standard V-shaped bows, especially in rough seas. The bulbous bow was built into the *George H.W. Bush* and will be on all *Gerald R. Ford*-class carriers.

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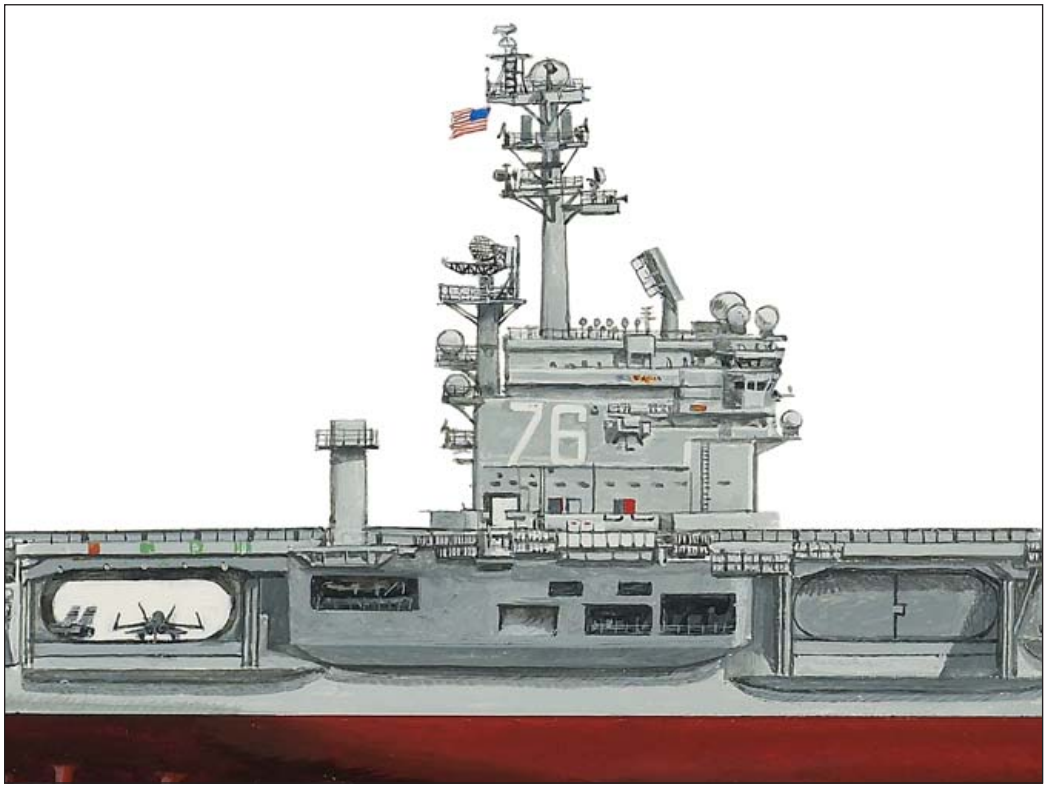

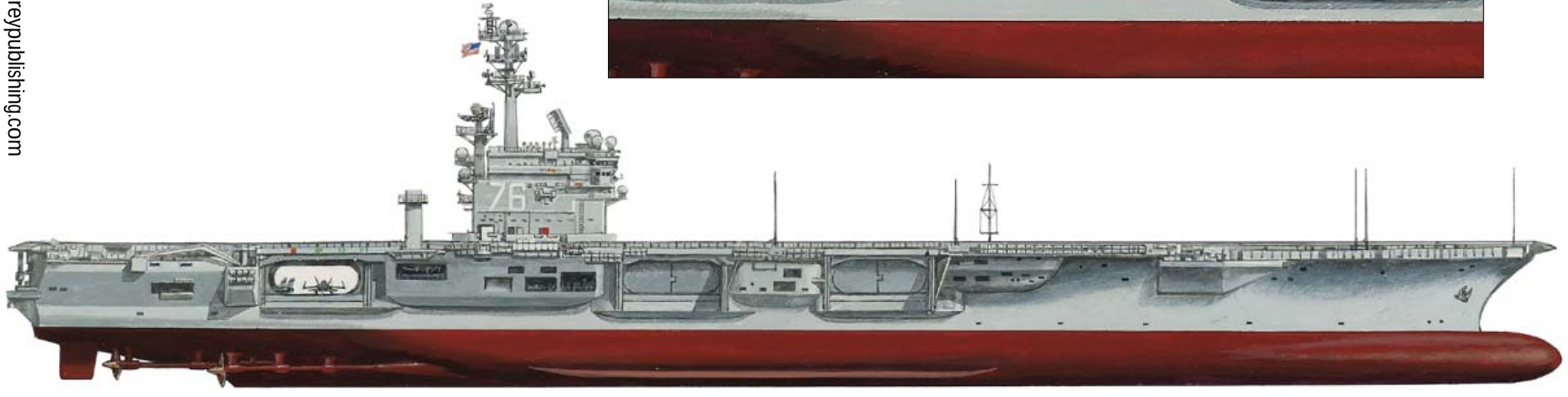

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Ronald Reagan (CVN 76) saw the addition of the bulbous bow, which provides added stability, especially in rough seas. It was incorporated into *George H.W. Bush* (CVN 77) and *Gerald Ford* (CVN 78). (Northrop Grumman Shipbuilding Newport News).

The last *Nimitz*-class carrier, named after World War II naval aviator and the 41st President of the United States, *George H.W. Bush* was commissioned on January 10, 2009, in a ceremony attended by its namesake and then-President George W. Bush. The carrier introduces several new features, many of which will become standard for the new *Gerald R. Ford* class, and will be retrofitted to earlier *Nimitz*-class carriers as they enter RCOH or extended DPIA maintenance periods. At one point, consideration had been given to naming CVN 77 USS *Lexington*.

George H.W. Bush includes a composite main mast and a modernized island structure that reduces topside weight and radar signature. The mast is a tapered square pole rather than the round mast seen on earlier designs. Both Pri-Fly and the Bridge have enlarged transparent armored windows, and the aft mast, found on the flight deck of earlier *Nimitz*-class carriers, was relocated to the island. Finally, a weapons elevator was relocated from the centerline of the flight deck to the aft section of the island, to aid in movement of aircraft ordnance during flight operations. Another is located at the flight deck edge.

The *Gerald R. Ford* was the first carrier to be designed using a 3-D modeling computer, which allows designers to see the arrangement of the ship's interior and systems and to locate potential problems in advance of building. As with the *Ronald Reagan*, *George H. W. Bush* has three arrester wires, and also a new arresting system, the digitally controlled Advanced Recovery Control System (ARCS). The JP-5 fuel system has been reconfigured and a new television studio, self-service laundry, and F/A-18 Hornet complex added. A new paint system has been applied to the hull, extending its life from eight to 12 years. The carrier also has modernized deck coverings, which reduce its overall weight by more than 100 tons (90.7 tonnes).

On May 19, 2009, an F/A-18F Super Hornet from Air Test and Evaluation Squadron 23 (VX-23) became the first aircraft to launch from the carrier's flight deck. The carrier will complete work-up late in 2010 for its 2011 deployment.

The newest *Nimitz*-class carrier, USS *George H.W. Bush* (CVN 77), is seen here during sea trials. The vessel completed carrier qualifications during the summer of 2009 and made its first deployment in 2010. (Northrop Grumman Newport News Shipyard).

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A computer illustration of USS *Gerald R. Ford* (CVN 78), shows its smaller, redesigned island and larger flight deck. The *Ford*-class also has only three elevators, the No. 3 elevator having been removed and the island repositioned further aft. (Northrop Grumman Shipbuilding Newport News).

Nimitz-Class Follow-on: The USS *Gerald R. Ford* (CVN 78) Class

With the end of the *Nimitz*-class construction, a new class of nuclear carriers is emerging as part of the *Gerald R. Ford* class. The class represents an incremental departure from the last *Nimitz*-class vessel, CVN 77, and incorporates many of the design modifications built into *Reagan* and *George H.W. Bush*. Not only will the island be reduced in size, it will contain fewer yet more capable radars, including the SPY-2 volume search and SPY-3 MFR (Multi-Functional Radar) for target detection, tracking, and illumination. The next carrier in the class, CVN 79, will feature a larger hull, an enlarged flight deck with refueling and rearming stations, and a cableless arresting system. The keel for the new carrier was ceremonially laid on November 14, 2009, in Dry Dock 12.

Gerald R. Ford had its beginnings in the CVN 21 studies of the late 1990s, which sought a next-generation replacement for the *Nimitz*-class carriers. When it enters service in 2015, *Gerald R. Ford* will replace *Enterprise*. *Nimitz* is expected to be retired in 2024, to be replaced by CVN 79. As of 2010, lead funding for CVN 79 and CVN 80 (replacing *Dwight D. Eisenhower*) is already underway. On January 15, 2009, a $374 million contract was awarded to NGSB-NN for design work and construction preparation for CVN 79. No names for the carriers have been yet designated, although groups are already advocating such historic titles as *United States*, *Wasp*, *Arizona*, *Barry M. Goldwater*, and even *Enterprise* (this would make it the ninth *Enterprise* in Navy history). In any event, the *Nimitz* class will remain a vital part of America's carrier force well past 2050.

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INDEX

Figures in **bold** refer to illustrations

Adriatic Sea **40–41**
Afghanistan **31**, 43
aircraft 4–7, **12–13**, 14–15, **17**, 18–19, 22–23, 30
  aircraft launch and recovery 14, **15**, 16, **17**, **20–21**, **32–33**, 43
  arresting gear 6, **8–9**, **12–13**, 16–18, **17**, 44, 46
  launch and landing systems 9, 15, **15**, 18–19, **20–21**, 29, **29**, **32**
  monitoring systems 14, **15**
  aircraft ordnance 14, 31, 44
aircraft types
  Boeing P-8 Poseidon 30
  Convair B-36 Peacemaker 7
  Douglas A-3 Skywarrior and variants 8, 19, 31
  Grumman A-6 Intruder and variants **19**, 30–31, **31–33**
  Grumman E-2 Hawkeye and variants 22, **29**, 30–31, **31**, 37, **42–43**
  Grumman F-14 Tomcat and variants **12**, **14**, **18**, 19, **20–21**, 30–31, **30–31**, 37–39, **37**, **39**, 41
  Ling-Temco-Vought A-7 Corsair II and variants 30–31
  Lockheed P-3 Orion 30
  Lockheed S-3 Viking and variants 31, 41
  Lockheed Martin F-35 Lightning II Joint Strike Fighter 31
  McDonnell Douglas F-4 Phantom II and variants 16, **22**, 30–31
  McDonnell Douglas F/A-18 Hornet and variants**12**, **16–17**, **19–21**, **27**, 31, **32–33**, 37, **37**, 43, **43**, 46
  North American AJ-1 Savage 8
  North American A-5 Vigilante and variants **8–9**, 16, 31
  Sikorsky SH-3D Sea King helicopter 31
  Sikorsky SH-60 Seahawk helicopter and variants **29**, 31–32, **32**, 41
air traffic control 13, 22
amphibious operations and warships 7, 30
Arabian Gulf/Arabian Sea **29**, 44
Atlantic Ocean **32–33**

bow 44, **44–45**, **46**
bridge and bridge systems 20, 44

carrier air wings and groups 6–8, 11, **12**, 18–20, **18**, **20–21**, 22–23, **24–25**, 30–32, 35–36, 38, 40, **40–41**, 41, 43–44
CVW 7 **38**, 41
CVW 8 **20–21**, 31, 39, **40–41**
carrier strike groups 23, 37
catapults 6, **6**, 7, **8–9**, 9, 11–12, **12–14**, 15–16, **16–18**, **27**, **32–33**, 33, **37**, **39**, **43**
command-and-control facilities 20, 22, 23
communications equipment (see also satellite communications) **23**, 27–28, **29**
cruisers 10, 23, **26**

defensive systems (see also radar) 7, 23, **26**, 29, 30, 34, **44–45**
close-in weapons system (CIWS) 26, **26**, **27**, **28**, 29, 38, 41, 43
  guns 7, 23, 26, **26**
  decoys and decoy systems **26**, 27, 29
  electronic-warfare systems 30, **32–33**
  missiles and missile systems 23, 26–27, **26–28**, 29–30, 38, **38**, 41, 43
  torpedo countermeasures systems 27
  destroyers 10, 23

elevators 10, **11**, 14, 19, **19**, **24–25**, **37**, 44, **44–45**, **47**
Essex-class carriers 5, 6, 8, 9, 12, 22
exercises 36, 41, **38**

fire-control systems 23–26
flag bridge and plot **8–9**, 20
flight deck 6–7, **6**, 9–12, **11**, **12–13**, 14–15, 17, **17**, 19–20, **24–25**, 35, **39**, **43**, 44, **44–45**, **47**
Forrestal-class carriers 9, 11–12, **11**, 14–15
Forrestal, James V. 9, **10**
frigates 10, 23
fuel and refueling 6, 14, **15**, 34, 36, 46

Gerald R. Ford-class carriers 5, 17, 34, **44–45**, 46, 47, **47**
Great Britain 5, 9

hangar bay and deck 14, 19, **19**, 20, **24–25**, **42**
helicopters, see also aircraft types **29**, 31–32, **32**, 38

Indian Ocean 15, **32–33**, 41
intelligence 22–23, 29
Iraq 38, 43
island **4**, **8–9**, 10, **11**, 14, 20, 27, **28–29**, 34, 42, 44, **44–45**, 47, **47**

Japan 5, 34, 35, 42
jet blast deflectors (JBDs) 12–14, 16, **16**, **32–33**
Kitty Hawk-class carriers 9, 10, 11, 14

Mediterranean Sea **32–33**
Midway-class carriers 6–9
movies and TV documentaries, *Nimitz*-class carriers in 37, 38, 43

naval air stations 36, 44, **30**
Newport News VA 8, 36, 37, 39
nicknames, carrier 36–42, 44
Nimitz-class carriers 5, **10**, **12–13**, 12, 14–18, **23–26**, 26–27, 29–30, 32, **32–33**, 34, 36, 38, **40–41**, 46–47
Norfolk VA **32–33**, 42–43
Northrop Grumman Shipbuilding Newport News (NGSB-NN) 8, 36, 47

operations 38, 43
Operation *Allied Force* 39, **40–41**
Operation *Desert Storm* 39–40, **40–41**
Operation *Enduring Freedom* **18**, **31**, 38–39, **40–41**, 41, 43, 44
Operation *Iraqi Freedom* 15, 37, **37**, 39, **40–41**, 41
Operation *Southern Watch* 37–38

Pacific Ocean **16**, **29**, **42**
Persian Gulf 15, **32–33**, 41
personnel 14–15, 18, **18**, 22, **24–25**, 29, 32, 34–35, 38, 40–41
primary flight control ("pri-fly") 14, 20, 22, 44
propulsion, powerplant and navigation 7, 32, 34
engines 7, **24–25**, 32
nuclear reactors 10–11, **11**, 15, **24–25**, 32, 34, 38
propellers and shafts 7, 33, **33**, 39

radar 5, **8–9**, 10–11, 20, 27, 30, **42**, 44, 47
  aircraft landing, see aircraft launch and recovery
  air-search **8–9**, 10–11, 28–31, **29**, **31**, 44, 47
  defense23, 26, 29–30, 41
  multi-function radar 47
  navigation 28
  surface-search **8–9**, 28
  target acquisition and tracking 10, 23–26, 41
refueling and complex overhaul (RCOH) 16, 20, 26, 28, **28–29**, 34–35, **34**, 38–39, **38**, 46
replenishment **35**, 36
Royal Navy 4, 9, 18

satellite communications (SATCOM) **8–9**, **23**, **27**, 27–29, **28–29**, **42**, 43
ship construction and design 36, **40–41**, **44–45**, 46
submarines and anti-submarine warfare 10, 22–23, 31, **32**, 38, 40

torpedoes 12, 27, 31
training 35–36
trials, sea and combat 35, **38**, **43**, **46**
Truman, President Harry S. 7–8

United States of America 5, 9
US Air Force (USAF) 7–8
US Navy 4, 6–11, 18, **20–21**, 23, **27**, 35–36
  Atlantic Fleet **32–33**, 34
  carrier strike groups (CSGs) 5, 23, 35, 36, 37, 41
  Pacific Fleet **32–33**, 34, 37, 39
US Navy air squadrons **14**, **16–17**, **19**, **22**, 31–32, **32**, 35, **40–42**, 41, 43, 46
  VAQ-130 "Zappers" **19**, 31, **32–33**
  VF-31 "Tomcatters" **20–21**, **30**, 31, 39
  VF-213 **20–21**, **30**, 39
  VFA-41 "Black Aces" **20–21**
  VFA-102 "Diamondbacks" **16**, **18**
US Navy bases 34
  Coronado CA 34, 39, 42
  Yokosuka, Japan 34, 42, **42**
US Navy vessels (carriers unless otherwise specified)
  CVN 79 and 80 planned carriers47
  USS *Abraham Lincoln* (CVN 72) 15, **20–21**, 23, 33, 35, 40–41
  USS *Abraham Lincoln* (SSBN 602) submarine 40
  USS *America* (CVA 66) 9
  USS *Birmingham* (CL2) cruiser 4
  USS *Carl Vinson* (CVN 70) **8–9**, 16, **17**, 22–23, 26–28, **29**, 32–33, **32**, 36, 38–39, **38**
  USS *Constellation* (CVA 64) 9
  USS *Coral Sea* (CVB 43) 6
  USS *Curts* (FFG 38) cruiser 23
  USS *Dwight D. Eisenhower* (CVN 69) **8–9**, 16, 20, 22–23, 26, 28–30, **28**, **29**, 32–33, 36–38, **35**, **38**, 47
  USS *Enterprise* (CVN 65/CVAN 65) 5, 10–11, **11**, 26, 32–33, 47
  USS *Essex* (CV 9) 6
  USS *Ford* (FFG 54) cruiser 23
  USS *Forrestal* (CV 59) 9, 10, **10**, 23
  USS *Franklin D. Roosevelt* (CVB 42) 6, **12–13**
  USS *George H. W. Bush* (CVN 77) **12–13**, 17, 20, **24–25**, 26, 30, 33, **33**, 39, 44, **44–45**, 46–47, **46**
  USS *George Washington* (CVN 73) **14**, **16**, 18, 26, **27**, 28–29, 33, 36, 41–42, **42**
  USS *Gerald R. Ford* (CVN 78) 15, 33, **44–45**, 46, **46**, **47**
  USS *Harry S. Truman* (CVN 75) 17, **19**, 20, 26, **26**, 28, **28**, **32–33**, 33, **35**, 36, 43, **43**
  USS *Independence* (CVA 62) 9
  USS *Ingraham* (FFG 61) cruiser 23
  USS *John C. Stennis* (CVN 74) 28, 32–33, 36, 42–43, **42**
  USS *John F. Kennedy* (CVA 67) 9, 11, 32, 39
  USS *Jupiter* (AC 3) experimental carrier 4
  USS *Kitty Hawk* (CV 63, formerly CVA 63) 9, **11**, 41, **42**
  USS *Langley* (CV 1) 4
  USS *Lexington* (CV 2) 5
  USS *Midway* (CVB 41) 6
  USS *Mobile Bay* (CG 53) cruiser 23
  USS *Monsoon* (DDG 92) destroyer 23
  USS *Nimitz* (CVN 68/CVAN 68) 5, **8–9**, 10–11, **12–13**, 15–17, 20, **20–21**, 22–23, **22**, **23**, **24–25**, 26–29, 31–33, 36–37, **37**
  USS *Paul Hamilton* (DDG 60) destroyer **36**
  USS *Pennsylvania* (ARC 4) cruiser 4
  USS *Ranger* (CV 4) 5
  USS *Ranger* (CVA 61) 9
  USS *Rodney M. Davis* (FFG 60) cruiser 23
  USS *Ronald Reagan* (CVN 76) **4**, **12–13**, 17, 20, 26, 28–30, 33, 36, **36**, **39**, 41, 44, **44–46**, 46–47
  USS *Russell* (DDG 59) destroyer 23
  USS *Saratoga* (CV 3) 5
  USS *Saratoga* (CVA 60) 9
  USS *Shoup* (DDG 86) destroyer 23
  USS *Theodore Roosevelt* (CVN 71) 15, **16**, **18**, 22, 26–29, **27**, **30–31**, 33, 35–36, 39, **39–41**, **44–45**
  USS *United States* (CVA 58) proposed 'supercarrier' 6, **6**, 8–10, 43, 47

World War II 5, 7, 12, 18, 37, 41

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